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SECTION A.—PHYSICS.

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SCIENCE ABSTRACTS.

Section A.—PHYSICS.

NOVEMBER 1925.

GENERAL PHYSICS.

2408. *The Vector-Trolley Apparatus. The Principles and Problems of Vector Combination demonstrated.* **E. J. Atkinson.** (Journ. Sci. Instruments, 2. pp. 324–329, July, and pp. 348–352, Aug., 1925.)—Description of an apparatus designed to illustrate various mechanical principles, such as the parallelograms of accelerations and velocities, the principles of relative motion, the parabolic motion of the projectile, and Newton's second law of motion. It consists essentially of two trolleys actuated by adjustable falling weights, the combined effect of the independent motions of these trolleys in directions inclined at suitable angles to one another being recorded by means of a tracer. E. G.

2409. *Some Physical Properties of Aniline and its Aqueous Solutions.* **M. P. Applebey** and **P. G. Davies.** (Chem. Soc., J. 127. pp. 1836–1840, Aug., 1925.)—The density of a saturated (or about 5 %) solution of aniline in water at 20° C. is $d_{20°}^{20°} = 1{\cdot}02393$, the value for pure aniline being 1·02315. The refractive index is a linear function of the percentage composition as is given by the equation $n_{\mathrm{D}}^{20°} = 1{\cdot}58685 - 0{\cdot}00270p$, where p is the percentage of water. Measurements of viscosity give results which obey Poiseuille's law, but vary with time, showing that changes take place with freshly distilled aniline even when stored in a desiccator in the dark. Measurements of freezing-point show that a eutectic occurs on the aniline side of F.P. — 11·85° C. with 2·575 % of water, the solid separating from solutions containing more than this amount of water being ice. Measurements made on the water side are somewhat uncertain. Taking 58·7 as the cryoscopic constant for aniline, the calculated molecular weight of water rises from 22·9 in very dilute solution to 25·1 in a solution in the neighbourhood of the eutectic. There is thus clear evidence of association of water in aniline solution. The freezing-points of the dilute solutions of aniline in water also indicate association of the solute, the molecular weight calculated being about 105 instead of 93. J. N. P.

2410. *Osmotic Pressure by the Solubility Method in Concentrated Solutions.* **M. P. Applebey** and **P. G. Davies.** (Chem. Soc., J. 127.

pp. 1840–1846, Aug., 1925.)—An investigation is made of the relations determining the diminution of the solubility of water in aniline through the presence of a solute (sucrose) which is only soluble in the water phase. For the determination of the concentration of equilibrium solutions the different physical properties mentioned in the preceding abstract were found inapplicable. Direct solubility measurements are therefore made by observing the temperature at which turbidity occurs on cooling and disappears on heating the aniline phase, and comparing the results with a solubility curve obtained by measuring the temperatures of saturation of known mixtures of aniline and water. Data on osmotic pressure at different concentrations are deduced from the lowering of the freezing-point and compared with the values determined by Berkeley and Hartley by the method of conjugate osmotic pressures. As with the Nernst dilute solution formula, the agreement is fairly satisfactory only at low concentrations. It is concluded that the solubility method is not capable of giving accurate determinations of osmotic pressures, but that comparative results may be obtained by finding the percentage of water in the aniline phase in equilibrium with a solution of unknown osmotic pressure, and reading off from the results the concentration of the sucrose solution which is in equilibrium with the same aniline solution. The osmotic pressure of the unknown solution may then be equated to that of the sucrose solution. J. N. P.

2411. *Variation of Surface Tension of Liquids under the Influence of Radiation.* **A. Grumbach** and **S. Schlivitch.** (Comptes Rendus, 181. pp. 241–243, Aug. 10, 1925.)—Excepting Popesco's discovery of the diminution of the surface tension of mercury emitting photoelectrons (Popesco, "On the Capillary and Photoelectric Properties of Mercury," *Thesis*, Paris, 1924, p. 91), no action of radiation on the capillary constant of liquids has hitherto been established. The authors obtained positive results by a method based on a process used for showing variation of capillary constant with temperature. A liquid index is introduced into a cylindrical horizontal tube. If the surface tension varies on one meniscus, the liquid moistening the glass moves in the direction of maximum surface tension. The displacements are measured by a microscope with an ocular micrometer. The index formed by the active liquid is displaced on the side of the meniscus illuminated by the mercury lamp, the remainder of the liquid being kept in the dark. No displacements in a contrary direction have hitherto been observed. Thus there is increase of surface tension under the influence of radiation. The apparatus may be converted into a sensitive manometer by slightly curving the centre of the tube downwards. The index then mounts a slope of the illuminated side and attains a position of equilibrium. The tube was immersed in a glass vessel containing 5 litres of water and serving as a thermostat. An index of distilled water, alcohol or pure xylene was not displaced on illuminating one meniscus, whereas an alternating motion was obtained by illuminating in turn the extremities of the index. Very clear results were given by the following liquids: solution of fluorescein in water or alcohol; aqueous solution of sodium naphthionate; aqueous solution of sulphofluorine and its potassium salt; aqueous solution of uranyl nitrate; anthracene dissolved in xylene; xylene in alcohol; ordinary paraffin. Comparing these results with those obtained in studying cells with a fluorescent liquid [see Abstract 1772 (1925)], it

may be foreseen that certain radiations will modify the surface tension at the limit of a liquid, but that the phenomenon may be complicated by effects due to other causes. E. F.

2412. *The Kinetic Theory of Surface Films. Part I. The Surfaces of Solutions.* **R. K. Schofield** and **E. K. Rideal.** (Roy. Soc., Proc. 109. pp. 57–77, Sept. 1, 1925.)—The relation between surface tension and concentration with aqueous solutions of a number of capillary active organic substances is examined at the interfaces water-air, water-benzene and water-mercury. The data obtained are in agreement with the equation $F(A - B) = xRT$, where F is the lowering of the surface tension, A is the area occupied by a gramme mol. of the active substance at the interface, B is the limiting area of a gramme mol. under high compression, and $1/x$ is a measure of the lateral molecular cohesion. The common value for B of 24–25 Å.U. which is found for normal fatty acids supports Langmuir's orientation hypothesis. The values of x for a series of fatty acids shows that at a water-air interface the lateral molecular cohesion increases with the length of the hydrocarbon chain. There is little or no cohesion between such molecules at a water-benzene interface. Sucrose molecules do not cohere at a water-mercury interface. It is concluded that the molecules of the capillary active substances examined are absorbed from a weak solution in a unimolecular layer, and that the effect they produce on the surface tension is due to their thermal agitation alone. At a given temperature their effectiveness depends solely on their surface concentration, their interfacial areas and their lateral cohesion. J. N. P.

2413. *Capillary and Photoelectric Properties of Mercury.* **J. G. Popesco.** (Ann. de Physique, 3. pp. 402–464, May–June, 1925.)—The surface tension of mercury is measured by the large drop method, a detailed account of the experiments and apparatus employed being given. When the drop is formed and measured *in vacuo* the surface tension is 436·3 dynes/cm., but on exposure to various gases (pure dry air, O, N, H, CO_2, SO_2, NH_3) at different pressures the surface tension is reduced. When, however, the drop is formed in the presence of a gas, the surface tension is at first increased, and then suffers progressive decrease to a limiting value reached, for example, in about twenty-four hours. Exposure to a gas of a drop formed *in vacuo* affects also the photoelectric emission. Measurements are made of the critical potential when the drop is exposed to a mercury arc in quartz and the initial maximum speed of electrons emitted calculated from Lenard's formula. It is found that these speeds decrease on exposure of the drop to gases, and that the diminution is sensibly proportional to the corresponding diminution of surface tension. Ultra-violet rays, when allowed to act upon a drop of Hg *in vacuo* and negatively charged, also produce a diminution of surface tension correlative with the photoelectric emission. The results obtained are discussed in relation to the theoretical views of Frenkel and Harkins, assuming the adsorption of gases by Hg and also in relation to the question of the orientation of the superficial atoms. A. B. C. L.

2414. *Boundary Lubrication.* **W. Hardy** and **I. Bircumshaw.** (Roy. Soc., Proc. 108. pp. 1–27, May 1, 1925.)—A continuation of earlier work, the spherical slider used in studying friction being replaced by a plane

one. It is deduced that (1) with a plane slider the coefficient is a function of the load with increasing loads until a point is reached where it becomes constant, but with a spherical slider it is always independent of the load ; (2) with low pressure the efficiency of the lubricant increases as the pressure increases till a limit is reached. Beyond this limit Amonton's law holds. It appears that during the first period the slider is floating on a layer of lubricant whose thickness is a function of the pressure, while in the second period a layer of constant molecular composition exists. J. L. H.

2415. *Plastic Extension and Fracture of Aluminium Crystals.* **G. I. Taylor** and **C. F. Elam.** (Roy. Soc., Proc. 108. pp. 28–51, May 1, 1925.)—Experiments were carried out in which six single crystal test pieces of aluminium were stressed to fracture. The crystal axes were determined by X-rays before straining, and the distortions and axes determined at various stages during the operation. Generally, in the earlier stages of deformation the distortion produced is that due to slipping on a single plane, but during the last stages slipping takes place on two planes. In one specimen the axis of the specimen was very close to a (112) axis and slipping took place on two sets of planes. Methods of predicting the plane and direction of slip are given and are verified experimentally and the conditions for practice are discussed. J. L. H.

2416. *Determination of the Elasticity and Torsion Coefficients of Rock-salt and Sylvine at Low Temperatures.* **T. Steinebach.** (Zeits. f. Physik, 33. 9. pp. 664–680, 1925.)—Bending and torsion measurements are described which have been carried out on rock-salt and sylvine, both at room temperature and that of liquid air. Readings were made by a mirror arrangement attached to the crystals. The temperature coefficient is large for the modulus of elasticity, but smaller for that of torsion. Voigt's data for room temperatures are extrapolated for absolute zero. Since the compressibility and its temperature coefficient have been found as the differences of large numbers, the compressibility at absolute zero could not be evaluated from the data. However, the established temperature independence of the temperature coefficients of the elasticity constants enables the temperature dependence of compressibility data determined by Slater for higher temperatures to be extrapolated for absolute zero. Full experimental details are included. H. H. Ho.

2417. *On the Tensor Analytical Representation of the Theory of Elasticity.* **H. Thirring.** (Phys. Zeits. 26. pp. 518–522, Sept. 7, 1925.)—In this mathematical paper the fundamental equations of the theory of elasticity are transferred into any given system of curvilinear coordinates by the aid of tensor analysis. The physical interpretation of the tensor quantities involved is very clearly given. H. H. Ho.

2418. *On the Theory of the Detachment Method.* **J. J. Tichanowsky.** (Phys. Zeits. 26. pp. 522–525, Sept. 7, 1925.)—A complete survey of the theory of this method for the determination of the capillarity constant has not yet been published, and the present paper is an attempt to remedy the defect. It has not been found possible to give a general solution for the detachment problem, but six special cases are now mathematically considered, *viz.* circular plates of large and small radius

respectively, thin and thick rings of infinite radius and rectangular cross-section, ring of infinite radius and circular cross-section, and a straight horizontal bar of circular cross-section of very small radius in a rectangular frame. Lenard's solutions for the thin ring and bar are also discussed. Further work is promised. H. H. Ho.

2419. *Laws of Elasticity in "Tensorial" Form Valid for Any Given Coordinates.* **L. Brillouin.** (Ann. de Physique, 3. pp. 251–298, May–June, 1925.)—A mathematical analysis of magnitudes referred to as "pseudo-tensors" is introduced. Multiplied by $\sqrt{g}$, a given pseudo-tensor gives a true tensor, such a pseudo-tensor being described as a "tensorial capacity." The term "tensorial density" is analogously derived, being divided by $\sqrt{g}$ to give a tensor, and, generally, the product of a tensorial capacity by a "tensorial density" is a tensor. Equations are developed for solid media both in static and dynamic deformation. The study of adiabatic and isothermal transformations is included and an expression is found for the "density of energy" as a function of the deformation, of which Hooke's law is a special case. A. B. C. L.

2420. *An Approximate Determination of the Depth of Compression in Copper Bars during Impact.* **E. W. Tschudi.** (Phys. Rev. 25. pp. 125–132, July, 1925.)—As in previous experiments, the duration of impact was measured by means of a Duddell-type oscillograph connected in series with the pair of colliding bars, each of which was suspended by four wires adjusted so that the plane ends struck squarely. In all cases the mass of each bar tested was the same, 2400 gm. By trying three diameters of contact area d, it was found that the time varies as $1/d^{1/2}$; it also varies as $1/v^{1/5}$; hence $t = A/d^{1/2}v^{1/5}$, where A has the values $9{\cdot}7 \times 10^{-4}$ and $12{\cdot}35 \times 10^{-4}$ c.g.s. units for these steel and copper bars. The steel bars were then plated with coherent copper deposited electrolytically to thicknesses of 0·017, 0·038, 0·064 mm. The time for the two thick films came out the same as for solid copper, while that for the thinnest film was between that for copper and that for steel. These results indicate that the thickness of the surface layer whose elastic constants determine the time of impact is only about 0·03 mm. In the case of spherical ends of 1·27 cm. radius, impact at a velocity as low as 10 cm./sec. resulted in flattening the ends, the pressure exceeding the elastic limit for steel. AUTHOR.

2421. *The Characteristic Curves of Liquid Jets.* **E. Tyler** and **E. G. Richardson.** (Phys. Soc., Proc. 37. pp. 297–310; Disc., 310–311, Aug., 1925.)—Continuing the work of S. W. J. Smith and H. Moss [see Abstract 862 (1917)] upon the relation between the length of a capillary jet and its velocity of efflux from a cylindrical orifice, further examination has been made of the causes to which the main features of the curves obtained by these authors are due. Such curves consist of two main branches. In the first, with increasing velocity, the jet length rises until a critical point is reached. In the second, which begins at this point, the jet length diminishes rapidly with further increase of velocity. The results contained in the present paper indicate that, while surface tension is of prime importance in the first parts of these curves, viscosity is the dominating factor in the second. A general dimensional formula which covers both cases is derived. AUTHORS.

2422. *The Turbulence Problem for the Straight Circular Pipe.* **H. Lorenz.** (Phys. Zeits. 26. pp. 557–563, Sept. 17, 1925.)—Based on the view that for the case of turbulence the flow can be regarded as consisting of a core moving with average values of the velocity and a boundary layer opposed to the parallel flow but with non-linear velocity changes, which in the critical transition state just satisfy the tube conditions, the author has derived an equation for the whole mechanism of flow. This depends more on the critical Reynold number respecting the viscosity of the liquid than the frictional character of the boundary. The experimental results are satisfactory over a wide range. For unsteady states the work of Blasius has been adopted [see Abstract 989 (1912)].

H. H. Ho.

2423. *The Turbulence Problem and Allied Questions. I. Experimental Basis.* **L. Schiller.** (Phys. Zeits. 26. pp. 566–595, Sept. 17, 1925.)—A collected account of researches upon these problems from those of Hagen and Reynolds to the present time. A bibliography of over sixty published papers is given. W. G. B.

2424. *The Possibility of Fulfilling the Requirements of the Theory of Relativity in Classical Mechanics.* **E. Schrödinger.** (Ann. d. Physik, 77. 3. pp. 325–336, Aug., 1925.)—The dynamical theory of systems in which the total mutual energy of two point-masses μ, μ' separated by a distance r is given by $W = \gamma\mu\mu'\dot{r}^2/r - \mu\mu'/r$ is discussed. It is shown that the value deduced for the motion of the perihelion of mercury is in accord with that deduced from the theory of relativity if γ is given the value 3, the units being chosen so that the velocity of light and the gravitational constant are both equal to unity. The matter is discussed in the light of the criteria, postulated by Mach, to be satisfied by any system of mechanics, and which were not satisfied by the original form of Einstein's theory [see Abstract 853 (1916)]. J. S. G. T.

2425. *Stationary Electronic Orbits and the Method of Special Functions.* **K. Lanczos.** (Zeits. f. Physik, 33. 1–2. pp. 128–143, 1925.)—The author has previously shown [see Abstract 1574 (1925)] that the treatment of the oscillation equation follows as well for the scalar as for the vectorial potential when space is regarded as not of infinite extension but of closed spherical structure. It is now shown that the method of development by special functions affords an entirely new conception for the stationarity of periodic electronic motions and the character of the quantum conditions. A concrete solution is found to the classical problems of " How are periodic electronic motions possible without energy radiation ? " and " Why are the latter only possible under quite definite conditions ? " The paper is entirely mathematical. H. H. Ho.

2426. *The Periodic System and Elements which are Electronic Isomers.* **R. Swinne.** (Zeits. Elektrochem. 31. pp. 417–423, Aug., 1925. Paper read before the Deut. Bunsen Gesell., Darmstadt, May, 1925.)—Develops Stoner's theory of the electronic orbits, and gives tables which include his arrangements together with suggested arrangements for elements which have not been considered by him; these include a number of elements for which arrangements have recently been proposed by Sommerfeld; colour of compounds, magnetic properties and chemical valency

are throughout taken into account. S. Meyer has suggested, in order to account for the magnetic properties of the rare earths, that a single element may have two different forms, in which the electron orbits in the N or O groups are differently arranged; this might also lead to a difference of colour in compounds; some of the rare earths announced by Welsbach for which no place has been found in the periodic system may perhaps be explained in this way. Meyer has called them isotopes of higher order, but since it is supposed that the nuclei are identical and the difference is in the arrangement of the outer electrons, the author proposes to call them electron isomers. Every excited state of an atom without ionisation may be regarded as forming an electron isomer, or quantum isomer, as with hydrogen when the electron is in different Bohr orbits; a more complicated case, where the difference between the isomers is due to a difference between the relative orientations of the electron orbits, is seen in the relation between helium and parhelium. Some theoretical considerations dealing with the energy relations and the selection principle as applied to possible isomers are worked out, and facts are brought forward which suggest the existence of isomers in the iron group (magnetic behaviour, passivity), the palladium and the platinum groups. H. N. A.

2427. *Investigation concerning Sub-Electrons.* **H. Daecke.** (Phil. Mag. 50. pp. 637–644, Sept., 1925.)—The method used is described in a former paper [Abstract 788 (1925)]; the author concludes that the assumption that the sub-electrons may be represented in the form me/n, where n is not large and $m<n$ possesses greater probability than any other assumption. H. N. A.

2428. *A Physical Interpretation of Bohr's Stationary States.* **G. P. Thomson.** (Phil. Mag. 50. pp. 163–164, July, 1925.)—De Broglie has shown that the stationary states of an electron can be regarded as determined by the condition that the orbital motion of an electron can only be stable if the length of the path is such as to be in tune with the "phase wave" supposed to accompany the electron [Abstract 1156 (1924)]. A similar result may be obtained by supposing that the tube of force connecting electron and nucleus can transmit waves and that the determining condition is that the vibrations in this tube shall be in tune with the period of the orbit. The velocity of propagation of a disturbance along such a tube is shown to be $\frac{2e^2}{h}$ if Bohr's condition is fulfilled. The proposal is then to account for the failure of the classical theory by ascribing different properties to the tube of force according as to whether it is fixed only at one end and radiates into space or forms a bond between an electron and a nucleus. W. V. M.

2429. *Refraction and Electron Constraint in Ions and Molecules.* **C. P. Smyth.** (Phil. Mag. 50. pp. 361–375, Aug., 1925.)—In the problems of molecular structure and chemical activity the outer electrons of the atomic shells are of prime importance, and the constraints under which these electrons act may be decisive factors in determining the molecular behaviour. An approximate quantitative measurement of these constraints may be obtained from a consideration of the force necessary to displace the electrons from their positions of equilibrium or to alter or dis-

tort their orbits in the molecule. In the present paper such an alteration or distortion is treated as equivalent to a displacement of the effective position or position of equilibrium of the electron in the molecule. The forces opposing the displacement of the outer electrons in ions and molecules are calculated from the refractions. When the force cannot be calculated for an individual electron, the contribution to the refraction of a group of electrons is taken as an inverse measure of the average force acting upon these electrons. It is found that, where unsaturation exists, the constraint upon the electrons is low and that, in general, the forces exerted upon electrons shared between atoms, as well as those acting upon the unshared outer electrons of atoms or ions, decrease as the number of underlying electron shells increase and increase when the nuclear charge increases without increase in the number of underlying shells. H. H. Ho.

2430. *Formation and Breaking-up of Molecules.* **M. Polányi** and **E. Wigner.** (Zeits. f. Physik, 33. 5–6. pp. 429–434, 1925.)—Born and Franck have recently concluded that neither the formation of a molecule by simple association of atoms nor the opposite process of spontaneous separation can take place [Abstract 1253 (1925)]. The authors discuss the problem on the assumption that the quantum states have a finite "breadth," and that therefore there is a finite though sometimes a small probability that molecules may meet which have the energy required from the quantum standpoint to form a new molecule. Born and Franck, assuming that the above "breadth" is zero—that is to say, that the energy has a single definite value—concluded that the improbability of union is infinite. The authors consider that the adhesion of molecules to solid walls and the recent observation of Auger that an atom from which a K-electron has been torn by X-rays emits a second electron [Abstract 1124 (1925)] support their view. The electron comes from the L-layer and the energy comes from the passage of a second L-electron into the K-layer. Bothe has concluded that in the case of Br_2 half the ionised atoms emit the K-line and half split up in the manner indicated by Auger. Thus the probability of breaking-up is in this case equal to the probability of radiation. The theory is worked out thermodynamically. H. N. A.

2431. *The Electric Moments of the Molecules of Monocarboxylic Acids and their Esters.* **C. P. Smyth.** (Am. Chem. Soc., J. 47. pp. 1894–1900, July, 1925.)—In previous work [see Abstract 1070 (1924)] it has been assumed that each electron in an atom or molecule has an electrostatic effect equivalent to that which it would exert if located at some fixed point. The electric moments of the molecules of a number of monocarboxylic acids and esters are now calculated from their structures, which are assumed to be formed by the linking of atoms by electron pairs symmetrically located at the apices of regular tetrahedra. The ratio of the moments thus obtained to those previously calculated for the molecules of the ketones, aldehydes and alcohols is in good agreement with that of the moments obtained from experimental data on these substances. Differences in moment may arise from the mutual repulsion of bulky groups in a molecule and from differences between the structures of hydrocarbon chains as indicated by X-ray measurements. Results on chlorine substitution products show that the polarity of one

part of a molecule, which may determine the tendency of the molecule to ionise, may be altogether different from the polarity of the whole molecule as indicated by the electric moment. Support is given to the conception of valence forces as highly localised and directive in character. H. H. Ho.

2432. *The Theory of Atomic Structure.* **P. Jordan.** (Zeits. f. Physik, 33. 8. pp. 563–570, 1925.)—A recent paper by Pauli [Abstract 1875 (1925)] and another by Heisenberg have essentially improved the theory of the structure of multiplets and of the Zeeman-effect, and have connected it with the theory of the periodic system in Stoner's form. According to Pauli, the manifold of the states of an atom in a strong magnetic field can be deduced by combining the different possibilities of the orbital positions of the single electrons. The state of a single electron in a strong field can be described by means of four quantum numbers, which the author, following Landé, calls n, K, J, m, explaining the connection between this notation and that of Pauli. The manifold of the values assumed by these agrees with the manifold of the values of the quantum numbers of a doublet atom with the same designations. The author shows that for the case of spectra of the first order the theory makes it possible to coordinate the single spectral terms with the different combinations of the states of the valence electrons more definitely than has previously appeared possible. H. N. A.

2433. *The Structure of Glass.* **N. Seljakow, L. Strutinski** and **A. Krasnikow.** (Zeits. f. Physik, 33. 1–2. pp. 53–62, 1925.)—Calculates the curve for the energy distribution of scattered rays, due to cubical crystals containing only eight atoms, and finds that it contains a number of very distinct maxima, which would certainly be shown on an X-ray photograph. Good chemical glasses were photographed by the Debye method, and no trace of any lines was found. It is concluded that glass must be looked on as an under-cooled amorphous fluid. The existence of a region of critical temperature in glass, where refractive index, coefficient of expansion and electrical conductivity suddenly alter, is to be ascribed to molecular changes. The structure of α-cristobalite has been determined, and that of β-cristobalite has been investigated and a preliminary result obtained. H. N. A.

2434. *The Orientation of Crystals in Metal Test Pieces subjected to Small Strains followed by Heat Treatment.* **C. F. Elam.** (Phil. Mag. 50. pp. 517–520, Sept., 1925.)—Describes a method based on stereographic projection for recording the positions of the axes of the crystals observed. Sixty-four crystals produced by straining and heat treatment are recorded, and it is shown that the variety of orientation is great, although it appears possible that some directions are more favoured than others. The direction of straining has little influence. H. N. A.

2435. *Determination of Particle Magnitude in Tungsten Powder.* **K. Agte, H. Schönborn** and **K. Schröter.** (Zeits. techn. Physik, 6. 7A. pp. 293-296, 1925.)—In preparing tungsten wires by sintering, the size of the particles of the powder is of importance. The authors consider different methods of determining this, starting with the use of a measuring vessel into which a weighed quantity of the powder is poured and its

volume determined, and proceeding to methods in which the amount of a dyestuff absorbed by the surfaces of the particles, the rate at which the powder is dissolved in a chemical reagent, which depends on the total surface and therefore on the size of the grains, the rate of fall in a liquid, and measurements with a microscope, are made use of. In the last two cases great care is necessary to avoid the binding together of a number of particles to form a larger grain. Details are given of a method based on fall through water, and a microscopical method in which the particles are embedded in melted bronze or copper, from which a section is cut after solidification. H. N. A.

2436. *Crystal Structure of Silver Phosphate and Silver Arsenate* (Ag_3XO_4). **R. W. G. Wyckoff.** (Am. J. Sci. 10. pp. 107–118, Aug., 1925.)—Laue and powder photographs of crystals of Ag_3PO_4 and Ag_3AsO_4 were prepared and analysed; accurate spacing measurements were made by means of comparison photographs of samples mixed with MgO, which does not react on either of these compounds; a_0, the edge of the unit cube, = 5·99 Å. for Ag_3PO_4 and 6·12 Å. for Ag_3AsO_4 from the X-ray measurements, or taking the density measurements into account, with two molecules in the unit cube, 6 Å. and 6·12 Å. The space group is probably Te-$_4$, with the following arrangement of the atoms:

Phosphorus, or arsenic, atoms (2*a*):

$$000\,;\ \tfrac{1}{2}\,\tfrac{1}{2}\,\tfrac{1}{2}.$$

Silver atoms (6*f*):

$$0\,\tfrac{1}{2}\,\tfrac{1}{4}\,;\ \tfrac{1}{4}\,0\,\tfrac{1}{2}\,;\ \tfrac{1}{2}\,\tfrac{1}{4}\,0\,;\ 0\,\tfrac{1}{2}\,\tfrac{3}{4}\,;\ \tfrac{3}{4}\,0\,\tfrac{1}{2}\,;\ \tfrac{1}{2}\,\tfrac{3}{4}\,0.$$

Oxygen atoms (8*a*):

$$u\,u\,u\,;\ \bar{u}\,u\,\bar{u}\,;\ u+\tfrac{1}{2},\,u+\tfrac{1}{2}\,;\ u+\tfrac{1}{2}\,;\ \tfrac{1}{2}-u,\,u+\tfrac{1}{2},\,\tfrac{1}{2}-u\,;$$
$$u\,\bar{u}\,\bar{u}\,;\ \bar{u}\,\bar{u}\,u\,;\ u+\tfrac{1}{2},\,\tfrac{1}{2}-u,\,\tfrac{1}{2}-u\,;\ \tfrac{1}{2}-u,\,\tfrac{1}{2}-u,\,u+\tfrac{1}{2},$$

where the value of u_0 is thus far undetermined. H. N. A.

2437. *Lattice Theory of the Crystal Structure of the Titanium Oxides, Rutile and Anatase.* **O. F. Bollnow.** (Zeits. f. Physik, 33. 10–11. pp. 741–759, 1925.)—Approximate theoretical conceptions of both the tetragonal crystal forms of titanium oxide, rutile and anatase, are first given, and then the ratio of the axes is estimated from the condition that the lattice energy should be a minimum. The anatase type of crystal does not appear to be like any others, but a series of crystals, those of the oxides of lead, tin, manganese and germanium, as well as magnesium fluoride, are similar to rutile. From numerical measurements of the ratio of the axes for rutile and anatase, as well as from the occurrence of both crystal forms together, it is easy to understand why the lattice energy is almost the same for both. [See Abstract 281 (1925).] A. W.

2438. *Ether-Drift Experiments at Mount Wilson.* **D. C. Miller.** (Nat. Acad. Sci., Proc. 11. pp. 306–314, June, 1925. Science, 61. pp. 617–621, June 19, 1925. Nature, 116. pp. 49–50, July 11, 1925.)—With respect to the Michelson and Morley experiment of 1887, Miller points out that they announced their conclusion as follows: "Considering the motion of the earth in its orbit only . . . the observations show

that the relative motion of the earth and the ether is probably less than one-sixth the earth's orbital velocity and certainly less than one-fourth," *i.e.* it is less than $7\frac{1}{2}$ kilometres per sec. This result was considered by many as a null result, often called a negative result. The result of the Morley and Miller repetition of the observations, with improved apparatus, in 1905 and 1906 was published as follows: "We may therefore declare that the experiment shows that if the ether near the apparatus did not move with it, the difference in velocity was less than 3·5 kilometres per sec., unless the effect on the materials annulled the effect sought. Some have thought that this experiment only proves that the ether in a certain basement room is carried along with it. We desire therefore to place the apparatus on a hill, to see if an effect can be there detected."

In 1905 Morley and Miller removed the apparatus from the Cleveland laboratory basement to a site about 300 ft. above Lake Erie and free from obstruction from buildings. Five sets of observations were made in 1905 and 1906, which gave a definite positive effect of about a tenth of the then expected drift. The experiments were resumed in 1921, at the Mount Wilson Observatory in California, at an elevation of about 6000 ft. The apparatus was substantially the same as that used by Morley and Miller from 1904 to 1906. At the Mount Wilson station, about 5000 single measures of the ether drift have been made at various times of day and night, reduced in 204 sets, each set consisting of observations made within one hour's time. They were made at four different epochs of the year: (1) April, 1921, 117 sets; (2) December, 1921, 42 sets; (3) September, 1924, 10 sets; (4) April, 1925, 35 sets. Each observation gives for a specified time the magnitude of the displacement of the interference fringes, together with the azimuth of the line of sight in which the displacement is a maximum. That is to say, the observations give directly the apparent relative motion of the earth and ether in kilometres per sec., together with the direction of the drift. Since the light in the interferometer travels along one arm and back, each observation indicates only the line in which the drift occurs, but does not indicate whether it is in the positive or negative direction. The only criterion for determining the direction in the given line is the consistency of observations made at different epochs.

The author states that the 1921–1925 experiments lead to the conclusion that there is a relative motion of the earth and the ether at the Mount Wilson Observatory of approximately 9 kilometres per sec.—about one-third of the earth's orbital velocity. In view of the Cleveland observations, this suggests a partial drag of the ether by the earth, which decreases with altitude. It is believed that a reconsideration of the Cleveland observations, from this point of view, will show that they are in accordance with this presumption and will lead to the conclusion that the Michelson-Morley experiment does not give a true zero result. A complete calculation of the observations, now in progress, together with further experiments to be made in the immediate future, should give definite indications regarding the absolute motion of the solar system in space. G. W. DE T.

2439. *Planetary Time and Einstein's Theory.* **H. Reichenbach.** (Zeits. f. Physik, 33. 8. pp. 628–634, 1925.)—A discussion is given of the problem as to how far astronomical measurements of the velocity of light by observations of the eclipse of Jupiter's moons can establish the

principle of the constancy of the velocity of light. It is concluded that we are here concerned with a problem of absolute transport time. A. W.

2440. *Space and Time in Relativist Geometry.* **G. Giorgi.** (Pontificia Accad. Sci. Nuovi Lincei, Atti, 78. [10 pp.], 1925.)—Writers are in disaccord as to whether time constitutes a true fourth dimension or not. This disaccord disappears if we say that in the Einsteinian world there is fusion but not confusion of time and space. Time and space constitute a unique continuum, four-dimensional; but this continuum differs from Euclidean space in being non-Kleinian; it admits absolute real hypercones or hyperconoids with their vertices at every point, which determine absolute separations between temporal and spatial geodesics. Transformations of the Lorentz group are limited to infinitesimal regions and never transform geodesics of the one type into those of the other. Permutations of time-axes into space-axes and *vice versa* can never be complete because no observer can acquire a velocity exceeding that of light. The physics of the universe differ much less from intuition and the traditional conceptions than would at first sight appear. A. D.

2441. *The Theory of Binary Gravitational Fields.* **G. Beck.** (Zeits. f. Physik, 33. 9. pp. 713–728, 1925.)—The theory developed by Weyl [see Abstract 605 (1918)] and Levi-Civita is extended to the discussion of gravitational fields possessing axial symmetry and being either dependent or independent of time, rotary or stationary. J. S. G. T.

2442. *On Mass and Energy.* **G. Temple.** (Phys. Soc., Proc. 37. pp. 269–278; Disc., 279–281, Aug., 1925.)—It is assumed that variations in the potential energy of a body (gravitational or electrostatic) are always accompanied by proportionate changes in its mass. Combining this assumption with the theories of Newtonian dynamics and Maxwellian electrodynamics, it has been found possible to predict all those phenomena, which are usually regarded as the crucial tests of the theories of relativity, both "special" and "general." AUTHOR.

2443. *Electromagnetic Theory of Quanta.* **F. R. Bichowsky.** (Washington Acad. Sci., J. 15. pp. 187–195, May 4, 1925.)—The author in this paper assumes four general equations, of which the Maxwell equations are special cases, in which the several undetermined functions are each equal to unity. The problem then attacked is to find what restrictions on the form of these functions is necessary to account for those facts of optics, electricity and magnetism which are successfully accounted for by the special Maxwell functions. Examination shows that, as far as pure optics is concerned, all the equations for velocity, refraction, reflection, polarisation and interference depend on the assumption that there are solutions of the electromagnetic equations of the form: $\nabla^2\chi - a^2\ddot{\chi} = 0$, where χ may be any function of the electric and magnetic force separately, and where a^2 for free space equals $1/c^2$; that, as far as optical theory is concerned, χ may be taken to be an undetermined function of the electric and magnetic fluxes, as may be seen by going through the proofs of the optical equations, and, moreover, intuitively from the fact that the purely optical equations do not explicitly involve either flux. It is also shown that any functions of h and d substituted in the Maxwell equations will lead to a solution consistent with all purely optical pheno-

mena, provided only the derivatives of the same functions are substituted for $\vec{h}$ and $\vec{d}$. Maxwell's equations are therefore the only possible electromagnetic equations which will lead to the facts of optics. The most striking result of the author's analysis is a proof of Planck's equation rigorously derived from the fundamental laws of dynamics with the aid of a self-consistent electromagnetic theory. G. W. DE T.

METEOROLOGY AND GEO-PHYSICS.

2444. *The Importance of Field Work in the Study of Climates.* **R. de C. Ward.** (Am. Phil. Soc., Proc. 64. 1. pp. 64–77, 1925.)—Three stages in the presentation of the climatic description of a district are dealt with: (1) numerical tabulation of standard climatological data, which is essential for scientific studies; (2) descriptive accounts of weather types and the effect of these on vegetation, crops and all human activities; (3) personal experience of weather and climate which involves field work. The records of the Lewis and Clark expedition to the sources of the Missouri across the Rocky Mountains and down the Columbia River to the Pacific in 1804–6 are cited as a classical example. The great value of well-chosen photographs and lantern slides in the presentation of the subject is also emphasised. R. S. R.

2445. *On the Relation between the Source of the Air and the Upper Air Temperature up to the Base of the Stratosphere.* **C. K. M. Douglas.** (Roy. Meteorolog. Soc., J. 51. pp. 229–237; Disc., pp. 237–238, July, 1925.)—The correlation between the temperature of the air at various levels and its previous history is determined on account of the distribution of temperature in the upper air being the main factor in determining the distribution of pressure and therefore of wind. Cases were selected where there was some evidence that the wind direction did not change greatly with height, and the trajectories of "gradient" winds were traced back on the surface charts for the North Atlantic. The trajectories were grouped according to seasons, and the results tabulated and shown also in diagrams. The chief results deduced are: (1) the correlations are greater for the displacement of the air three days previously (S_3) than for one day (S_1); (2) the standard deviation of temperature at fixed heights increases between 1 and 6 kms.; (3) the correlation of temperature with S_3 increases slightly from 1 to 6 kms.; (4) the correlations with the pressure at 9 kms. follow closely those with the temperatures underneath; (5) there is a well-marked correlation between S_3 and the height of, and temperature at, the base of the stratosphere; and (6) the correlation between S_3 and the temperature in the troposphere is higher in autumn and winter than in spring and summer. R. S. R.

2446. *The Energy of Saturated Air in a Natural Environment.* **N. Shaw** and **H. Fahmy.** (Roy. Meteorolog. Soc., J. 51. pp. 205–226; Disc., pp. 227–228, July, 1925.)—The thermal equations for dry and saturated air are first stated. The conditions governing the ascent of air are examined and a series of adiabatics constructed for saturated air. These are employed to ascertain the statical stability of the atmosphere for some individual ascents and for normal curves. The saturation adiabatics are next transformed into potential temperature curves. Instability resulting from the change of temperature of air masses is

considered, and the relations obtained are applied to a thunderstorm distribution and to the formation of rain. The saturated adiabatics are further transformed into a series of temperature and log. potential temperature curves. These curves are finally used in calculating the amounts of condensation and of energy in a kilogramme of air, and the kinetic energy and radius of the core of a cyclone. R. S. R.

2447. *Waves at an Approximately Horizontal Surface of Discontinuity in the Atmosphere.* **A. H. R. Goldie.** (Roy. Meteorolog. Soc., J. 51. pp. 239–246, July, 1925.)—Equations are established for the wave motion at the surface of separation of two currents of different densities, and the effect of these waves on autographic records of pressure and wind at the surface are considered. The relations are applied first to three cases of waves shown in the records for Eskdalemuir Observatory, and lastly in a detailed examination of the observations for several stations on August 14, 1914. In this last case a value is obtained for the difference of density in the two layers with a discontinuity at a height of 4 kms. [See also Abstract 2029 (1925).] R. S. R.

2448. *Registrations of Temperature and Relative Humidity in Polar and Equatorial Air over the Atlantic Ocean.* **K. Knoch.** (Meteorolog. Zeits. 42. pp. 297–302, Aug., 1925.)—Observations were made during the outward voyage of the *Deutschland* to the Weddell Sea in the summer of 1911. While proceeding to the Azores, and on leaving there, the ship passed on two occasions from polar into equatorial air and once in the reverse direction. Observations of cloud forms and rainfall, combined with the thermograms and hygrograms, confirm the views regarding polar air being unstable in its lower layers, of lower relative humidity, with good visibility and squally winds, while the reverse is the case for equatorial air. The thermograms and hygrograms show little general change in equatorial air, but in polar air there are frequent and considerable oscillations from the mean value. The change in type is not usually so marked on proceeding from polar to equatorial air, because of the existence of a wider transition layer. R. S. R.

2449. *Measurement of the Height of the Layer of Ozone in the Atmosphere.* **J. Cabannes** and **J. Dufay.** (Comptes Rendus, 181. pp. 302–304, Aug. 24, 1925.)—The mass of ozone passed through by solar radiation reaching the earth in a vertical direction is equivalent to a layer 0·3 cm. thick at normal pressure. The authors made measurements of changes in optical density as the sun was setting, using the part of the spectrum between 3160 and 3300 Å. and a mean value of 50 km. was obtained for the height of this ozone layer. Nine new bands for tellurium were also detected. R. S. R.

2450. *Polar Front Meteorology.* **V. Bjerknes.** (Roy. Meteorolog. Soc., J. 51. pp. 261–265; Disc., 265–268, July, 1925.)—A summary is given of a lecture which is essentially similar to another delivered earlier [see Abstract 490 (1925)]. In the *Discussion*, **N. Shaw** suggested small-scale experiments in a tank of water to illustrate the processes dealt with, and also that further information was required of conditions in the upper air before the theory could be established. **E. Gold** considered that with the assumed unstable conditions turbulence and not waves

along the polar front would result. **D. Brunt** dealt with difficulties of energy transformation in accepting the theory as it stood. **L. C. W. Bonacina** thought humidity differences were also involved in the formation of a cyclone. R. S. R.

2451. *Continental Mechanics.* **J. W. Evans.** (Nature, 116. pp. 173–175, Aug. 1, and pp. 212–215, Aug. 8, 1925. Presidential Address to the Geolog. Soc. of London, Feb., 1925.)—There are extensive areas of the earth's surface that have suffered compression, and such show folding of the rocks, slaty cleavage, and other structures due to thrusting. These phenomena of compression have received much attention, whilst the equally wide-spread phenomena due to tension have scarcely received notice. Tension leaves evidence of its action in joints, normal faults, and the intrusion of igneous dykes on a large scale—*e.g.*, the country between central Europe and Ireland has been stretched about nine miles as calculated from the width of dykes, and the effects of this are evident on drift charts of the north-west Atlantic. The significance of these tensional areas in the light of the Wegener hypothesis of continental drift is pointed out, and the influence of tensile stresses on the distribution of igneous rocks is considered in some detail. W. A. R.

ASTRO-PHYSICS.

2452. *Accurate Time Signals.* **F. Marre.** (Radioélectricité, 6. pp. 241–242, July 10, 1925.)—Jouaust and Mesny, of the French military time-service, have designed an instrument which will signal the meridian passage of a star across a transit-instrument in Paris to navigators on the ocean, without the interposition of any human observer, thus eliminating the personal error. The light from the star is made to fall on a photo-electric cell of potassium ; the feeble current thus generated is intensified a million times by an amplifying tube, such as is used in the Wireless Time Service, and it then sets in motion the waves which are sent forth as signals. A diagram of the instrument accompanies the description. M. A. E.

2453. *Radiometric Measurements of Stellar and Planetary Temperatures.* **W. W. Coblentz.** (Nature, 116. pp. 439–441, Sept. 19, 1925.)—[See also Abstract 2245 (1925).] E. F.

2454. *Theorem of v. Zeipel on Radiative Equilibrium.* **H. v. Zeipel.** (Roy. Astron. Soc., M.N. 85. pp. 678–681, June, 1925.)—A rejoinder to Jeans [Abstract 2042 (1925)]. Jeans' criticism is founded on the special case of Schwarzschild for which the theorem is admittedly not valid. The further criticism that the derivatives $d^3E/d\sigma^3$, $d^4E/d\sigma^4$ . . . are supposed to be zero, is shown not to be correct. The theorem is discussed in more detail than in the previous paper [Abstract 49 (1925)]. A. Wh.

2455. *The Mass-Luminosity Relation.* **J. H. Jeans.** (Roy. Astron. Soc., M.N. 85. pp. 792–797, June, 1925.)—A rejoinder to Eddington [Abstract 2039 (1925)]. Eddington gives an equation of the form : $m = f(M) + \text{const.}$ for the relation between absolute magnitude and mass, while the author believes the form to be : $m = F(M) + k \log T + \text{const.}$ Obviously this makes all the difference in the interpretation, since the first

makes the rate of radiation unique, while the second does not. The term k log T is certainly not " a small correction," and in fact Eddington prefers a larger value of k than the author had used. The physical consequences of the theory on the stability of gaseous spheres both to spherical and other displacements are discussed, and Eddington's conclusions are not agreed with. Particularly the statement that when radiation pressure nearly balances gravitation, the star will approach instability, is incorrect. There is no ground for differentiating the effects of radiation pressure and gas pressure in this connexion; and in any small star gas pressure and gravitation are nearly in equilibrium without causing instability. Radiation pressure does not introduce any new features qualitatively into the mechanical equilibria of these gaseous systems. A. Wh.

2456. *Width of Fraunhofer Lines.* **J. Q. Stewart.** (Roy. Astron. Soc., M.N. 85. pp. 732–738, June, 1925.)—A criticism of certain assumptions by Milne [see Abstract 1034 (1925)], which he took over from Tolman, that the width of Fraunhofer lines are due to Doppler-effect and mutual molecular influences, and not to " intrinsic width "; that is, to the intrinsic lack of sharpness in the " tuning " of the scattering molecules close to " resonance." The author examines the Doppler widening, and finds only in hydrogen a sufficient number of molecules to produce appreciable selective opacity; for hydrogen only is the Stark-effect line-widening effective; there is negligible broadening of lines from molecular collisions in gases of low density (10^{-5} atmos.) of the solar reversing layer. The two latter may operate low down near the photosphere, but not high in the chromosphere (which Milne studied), where molecules are so far apart that only " intrinsic " line-width comes in. He urges that practically all Fraunhofer absorption is in the reversing layer, where radiation is small as compared with gas-pressure. Electrostatic forces may be an important factor in the support of high-level ions. Three factors are concerned in forming Fraunhofer lines: (1) Selective opacity; (2) selective emissivity; (3) fluorescence. The " effective depth " is such depth that the integrated line-of-sight opacity for the given narrow frequency band corresponds to (say) 50 % reduction in the intensity of the direct beam; it is comparatively small at the centre of a line, but towards the edges it increases to that of the photosphere. Line-width has to do with the variation over the small frequency-range of the selective opacity of the stellar atmosphere. For the photosphere, effective depth depends on the general opacity of the gas, which increases with density and pressure; for the centre of a Fraunhofer line it is determined by the corresponding selective opacity, which is almost unaffected by density or pressure. [See next Abstract.] A. S. D. M.

2457. *Width of Fraunhofer Lines. Reply to J. Q. Stewart.* **E. A. Milne.** (Roy. Astron. Soc., M.N. 85. pp. 739–750, June, 1925).—The point of the author's method [see Abstract 1034 (1925)] is that it makes a sharp distinction between line-width and residual intensity, and shows that the formation, degree of permanence and law of density-distribution of the chromosphere are independent of any knowledge concerning the breadths of spectral lines. The " finite breadth " of an observed spectral line is attributed to (*a*) intrinsic breadth depending on the structure of the atom, (*b*) the effect of neighbouring atoms and of the Doppler-

effect. In resonance radiation the lines are extremely narrow, and so would be the H and K radiation in a narrow section of the upper chromosphere; it is these narrow lines which alone are investigated, and the author's analysis takes cognisance, not of the actual width of the Fraunhofer line, but of a narrow strip only, embedded in the middle of the absorbed broad Fraunhofer line, in which strip alone the atoms at high levels can be absorbing and emitting. He criticises Stewart's suggestion that effect (*a*) may give rise to the order of magnitude of the observed width of Fraunhofer lines. The number of atoms required to produce an observed solar line with a half-width of the order of 0·3 Å.U. and an observed central intensity-ratio of 1/10 is, whatever the physical origin, of the order of magnitude that can be supported by solar radiation-pressure against solar gravity. Stewart [see preceding Abstract] appears to be in error because he has not taken account of the observed order of magnitude of the intensity-ratio at the centre of a solar line.

A. S. D. M.

2458. *Absorption Coefficients and Radiation-Pressure in Stellar Photospheric Layers.* **E. A. Milne.** (Roy. Astron. Soc., M.N. 85. pp. 768–792, June, 1925.)—The author restates [see next Abstract] the formula for the atomic absorption coefficient, and applies it to the Balmer limit of hydrogen, finding that the mass absorption coefficient, $k^1(\nu) = 0{\cdot}73 \times 10^7$. Each atom in the Balmer state, therefore, is astonishingly opaque, and a layer of such atoms at temperature 10,000° and pressure of 1 atmos. would, if only 0·1 cm. thick, cut down an incident beam to $1/e$ of its value where e is the electronic charge. The mean mass coefficient of hydrogen in the Balmer lines is of the order of 10^7. The opacity of the photospheric layers is about a hundred times that of the interior. As the photospheric layers are penetrated from outside, the ratio of gas-pressure to radiation-pressure increases rapidly from zero, and there is a region ("the immediate interior") in which radiation-pressure increases rapidly from zero, and then another in which the ratio alters very slowly, changing only with the change in T^4, and gradually passing into Eddington's value calculated for the "far interior." Taking calcium as a typical element, the mass absorption coefficients in the photospheres of the sun and Capella are 1140 and 133·5 (as derived from Kramers' formula), or about twenty and three times Eddington's values for the far interiors. Paradoxically, k is greater for the dwarf stars, but radiation-pressure is the less important. For the sun $p_{\text{phot}} = 1{\cdot}12 \times 10^{-4}$ atmos., for Capella it is $1{\cdot}32 \times 10^{-5}$ atmos. (p_{phot} is the gas-pressure in the photosphere), in general agreement with estimates made in other ways. The author finds that for calcium or sodium vapour the opacity at 10^{-4} atmos. is about 7000 times as great as that given by Russell and Stewart's calculations. For p_{chrom} he obtains on the sun $1{\cdot}6 \times 10^{-7}$ atmos. This huge general opacity explains why the gaseous sun has a sharp edge; the opacity arises from the easy detachability of the series-electrons of atoms at the temperature of a stellar atmosphere. He deduces the ratio of pressures in the photosphere of a giant and a dwarf at the same effective temperature from the approximate formula $(p_1/p_2)_{\text{phot}} = (g_1/g_2)^{\frac{1}{4}}$, where the suffixes 1 and 2 refer to the giant and dwarf respectively; for different effective temperatures of giants and dwarfs of the same type

$$T_2/T_1 - 1 = [\log(g_2/g_1) - \log(T_2/T_1)] \div [2^{\frac{5}{4}}(\chi/kT_2)].$$

For the sun, the transition layer from complete transparency to complete opacity is about 70 km.; for the corresponding giant about 2700 km. The sun's flash-spectrum shows that the low-lying gases occupy a thickness of 100–400 km., and the author concludes that the gases of the reversing layer responsible for line-absorption must be very largely supported by radiation-pressure. The temperature gradient in the sun's immediate interior is about 150° per km.; in Capella 2° per km. He examines the fit of the "immediate interior" on to the "for interior," and compares it with Eddington's calculations. A. S. D. M.

2459. *Stellar Absorption Coefficient.* **E. A. Milne.** (Roy. Astron. Soc., M.N. 85. pp. 750–768, June, 1925.)—As a cause of the general opacity of the outer regions of a star, the author considers Russell and Stewart's suggestion of the scattering and absorption of radiation by free electrons and the "Rayleigh" scattering by bound electrons [see Abstract 2226 (1924)] and his own suggestion of photoelectric emissions, such as Eddington has suggested for the inner regions. He investigates, therefore, afresh the theoretical value of the absorption coefficient of a highly-ionised gas as based on Kramers' theory of X-ray coefficients. He takes first the part due to "free-free" electronic transitions, where a free electron encountering an atom (neutral or ionised) jumps from one hyperbolic orbit to another of smaller energy, finding a formula identical with Eddington's equation 7 in M.N. 84. 106, 1924. He takes next the part due to photoelectric emissions when a free electron encountering an ionised atom is captured in one of the energy-levels of the atom, obtaining finally the formula:

$$\alpha = \alpha_0 + \alpha_1 = \frac{80}{\pi^2\sqrt{3}} \cdot \frac{Z^2 e^6 h^2}{c(2\pi m)^{\frac{3}{2}}} \cdot \frac{P_e}{(kT)^{\frac{9}{2}}} \cdot \left(2 + \sum_{r=1} x_r + 1\frac{\chi_r}{kT} \cdot \frac{(n_r - Q_r)^2}{(n_r - \frac{1}{2} - Q_r)^2}\right)$$

as compared with Eddington's formula

$$\alpha' = \frac{80}{\pi^2\sqrt{3}} \cdot \frac{Z^2 h^2 e^6}{c(2\pi m)^{\frac{3}{2}}} \cdot \frac{P_e}{(kT)^{\frac{9}{2}}}\left(1 + \frac{\chi}{kT}\right)$$

the two differing only in their final factor. This difference arises from Kramer's application of the correspondence principle, and involves also the actual ionisation potentials of the atoms concerned. This factor makes the absorption coefficient greater by a multiple which may amount to 3. This goes some way towards removing Eddington's discrepancy, which in the case of Capella involved that the theoretical absorption coefficient is smaller than the astronomical value by a factor of 1/8. The author calculates the mass absorption coefficient at the centre of Capella, making allowance for Kramers' theory giving the X-ray coefficients too small, and finds for iron 8·8, titanium 18·6, calcium 21, and silver 25, bringing all nearer to Eddington's astronomical value of 47·5. He finds that Eddington's theory of nuclear capture, when corrected for the ionisation potentials concerned, leads to values of the absorption coefficient from 2·4 to 8 times greater than the astronomical value.

A. S. D. M.

LIGHT.

2460. *Ballistic Principle of Light-Velocity,* **M. la Rosa.** (Accad. Lincei, Atti, 1. pp. 488–493, May 2, 1925.)—The author rebuts two objections raised by Thirring [Abstract 1350 (1925)] to the ballistic theory. Of these the first is that the theory would involve waves of λ = some cms. arriving tail first from an atom; to which the reply is that from a congeries of atoms the ballistic theory brings out that these should be distinct spectral lines with a continuous background, as is the case. The second objection is that certain numerical results are at variance with the corresponding recorded facts of observation; to which the reply is a challenge of the recorded facts quoted, backed up by references to published tables. A. D.

2461. *On the Origin of the Impression of Lustre.* **H. Zocher** and **F. Reinicke.** (Zeits. f. Physik, 33. 1–2. pp. 12–27, 1925.)—After a brief mention of the literature on the subject, reference being made to the early work of Wundt and of the recent work of Esslen (Naturwiss. 10. 1056, 1922) and of Bancroft [Abstract 1031 (1919)], the author discusses in general terms the cause of lustre or gloss and methods of producing the impression of lustre which may be obtained by the employment of suitably arranged surfaces. These surfaces may consist of materials having a matt surface. From a physical point of view, lustre is defined as incomplete regular reflection. From a consideration of the nature of the surface a distinction is drawn between reflection lustre and matt lustre. The lustre of diamond, glass, or water comes in the first class, and mother-of-pearl and fat in the second. Surfaces which show reflection lustre when considered on a very small scale (like the human skin) may show a matt reflection on a large scale. The consideration of the different circumstances (variation of colour and light and shade) which lead to the impression of lustre are next discussed. Metallic reflection is due to intensity of lustre while a substance like barium sulphate may diffusively reflect nearly all the light which falls on it without the impression of lustre. The perception of solidity is next discussed, and the effect of stereoscopic vision. The remainder of the paper gives numerous examples of methods of producing the illusion of lustre. Many of these methods are employed in the textile industry; *e.g.* Schiller or changeant fabric and the Moiree effect may be cited.

T. B.

2462. *Phase Differences in Metallic Reflection.* **J. Richter.** (Ann. d. Physik, 77. 1. pp. 81–97, June, 1925.)—Revised measurements of phase differences on reflection from silver and from copper layers deposited on mica by kathode rays; λ from 500 to 680 $\mu\mu$; thicknesses, silver 0 to 150 $\mu\mu$, copper 0 to 70 $\mu\mu$. Comparison with Drude's calculated values for λ = 546,578 and 589 $\mu\mu$. Agreement found for thicknesses—silver 15 $\mu\mu$, copper 10 $\mu\mu$; the optical constants for massive metal being used. In further agreement with theory, the phase differences for silver and for copper reach constant values at a thickness of about 60 $\mu\mu$.

Pure silver transmits a blue light, pure copper a green with occasionally a coppery-red tinge. The metal lines are displaced towards the violet relative to the air lines. A. D.

2463. *Ultra-violet Absorption in very Dilute Solutions.* **R. Suhrmann** and **P. Huppert.** (Zeits. phys. Chem. 116. pp. 319–331, June 15, 1925.)—Salicylic acid in alcoholic solution and KNO_3 in aqueous solution have been believed to have an extinction coefficient practically independent of the concentration. It is found that they present notable departures from Beer's law when the solutions are very dilute. Reasons discussed. A. D.

2464. *The Relation between Contraction, Refraction and Absorption of Light in Aqueous Salt Solutions (Study of the Chemistry of Lithium. IV.).* **G. F. Hüttig** and **M. Keller.** (Zeits. Elektrochem. 31. pp. 390–403; Disc., 403–404, Aug., 1925. Paper read before the Deut. Bunsen Gesell., Darmstadt, May, 1925.)—A series of measurements was carried out to determine the contraction of volume at solution and the refractive index, dispersion and absorption of the resulting solution using LiCl, LiBr and LiI, of different concentrations. Precautions were taken to get absolutely pure materials, and the results of the measurements are tabulated and shown diagrammatically. The optical changes show similar features to the changes of volume, and these are ascribed to a hydration effect with the ions in which 6, 30 and 76 molecules of water form successively round the Li ion. This alteration produces the greatest effect with the iodide and the least with the chloride. The absorption effects indicate the presence of hydrated anions, and bands are obtained only if non-hydrated anions are present. R. S. R.

2465. *Spectral White-light Filter.* **H. Naumann.** (Zeits. wiss. Phot. 23. pp. 303–319, Aug., 1925.)—The paper, which contains a diagram of the apparatus, together with six graphs and a photographic record, deals with problems of artificial daylight, filters containing various dyes being considered. W. H. Ge.

2466. *Optical Properties of Mixed Crystals.* **Mary W. Porter.** (Roy. Soc., Proc. 109. pp. 78–98, Sept. 1, 1925.)—The variation of the principal refractive index, for vibrations along the axis of symmetry, in isomorphous mixtures of ammonium- and rubidium-magnesium sulphates, is a linear function of the composition, when expressed either as a volume percentage or as a molecular percentage, but not when expressed as a percentage by weight; the data were not sufficiently precise, however, to distinguish between the two former alternatives. The other two principal indices are also continuous functions of the composition, but their variation is represented by curves. T. M. L.

2467. *The "Effective Wave-length" in the Determination of Optical Rotation.* **H. Schulz.** (Zeits. Instrumentenk. 45. pp. 393–398, Aug., 1925.)—In many cases it is not convenient to use a definite spectroscopically isolated wave-length in polarimetric work. In such cases a filter is used which has some definite "effective wave-length." In the present paper it is shown that systematic errors due to rotational dispersion are reduced

if the temperature of the source is high. Some results dealing with effect of the width of the slit are also given. A. A. D.

2468. *Diffusion of Light in Fluids.* **Y. Rocard.** (Comptes Rendus, 181. pp. 212–213, Aug. 3, 1925.)—Examines up to what point the Gans theory agrees with molecular theories of diffusion of light. W. H. Ge.

2469. *Diffusion of Light and Ratio of the Absolute Delay in the Phenomenon of Kerr.* **Y. Rocard.** (Comptes Rendus, 181. pp. 283–285, Aug. 17, 1925.)—The depolarisation ρ of light diffused by a fluid and the ratio ψ of the absolute delay in the same fluid are connected by a very curious connection, the form of which depends otherwise on the conception made of the mechanism of diffusion on one hand and the mechanism of electrostriction on the other hand. This paper, which is of a mathematical nature, treats of the subject in two sections: (1) No supposition is made upon the variations of the index n and of the density D; (2) the index and the density are connected by the formula of Lorentz. A. E. G.

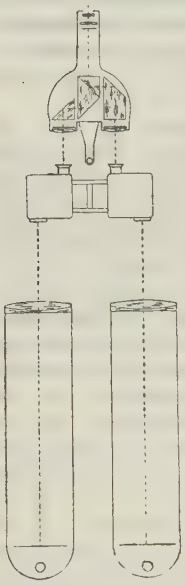
2470. *Optical Properties of Chemically Homologous Series.* **A. Krethlow.** (Zeits. wiss. Phot. 23. pp. 233–282, Aug., 1925.)—Deals with the optical and magnetic rotations, the dispersion, density, and absorption spectra of chemically homologous series. Some of the results are: (1) Contrary to the Verdet law, the specific magnetic rotation depends on the concentration, diminishing with diminishing concentration; (2) contrary to the Wiedemann law, the natural rotation increases quicker with decreasing wave-length than does the magnetic; (3) agreement is found between experimental values and those calculated on the Hagenbach law; (4) results calculated from the dispersion measurements disagree with those from the rotation measurements; (5) the theories of Lorentz-Livens and Oseen are not in accordance with the experimental facts. The paper includes eight figures and eighteen tables of results, and should be consulted in the original. W. H. Ge.

2471. *Calculation of Rotatory Power of a Tetrahedral Molecule.* **R. de Mallemann.** (Comptes Rendus, 181. pp. 298–300, Aug. 24, 1925.)—A previous calculation involved the assumption of atomic anisotropy, since terms of the second order cancelled out for isotropic atoms. This is no longer true of terms of the third order, and the conclusion is therefore drawn that "the existence of rotatory power, in an asymmetric molecule is not incompatible with optical isotropy of the atoms." This is important, since W. L. Bragg's calculation of the double refraction of calcite has shown that the atomic birefringence is neglible to a first approximation, in comparison with the effects of molecular birefringence. The expression deduced leads to the following conclusions: (1) The rotatory power depends only on the geometrical form of the tetrahedron and not on the particular position of the four atoms at the apices. These atoms certainly determine the form of the tetrahedron but the analysis does not call for any knowledge of the forces which produce the structure. (2) The rotatory power is proportional to the *product* of the refractivities of the four atoms. This explains the known influence of heavy atoms and of the mobile electrons of double bonds. (3) The rotatory power varies as the *eighth* power of the distance of the

atoms. An asymmetric molecule can therefore be treated by considering almost exclusively the asymmetric group of atoms, which behaves almost independently of the rest of the molecule. (4) The rotatory power is extremely sensitive to small changes of molecular structure, and is therefore a very delicate test for structural changes; it is therefore not surprising that the experimental variations have not been expressed by any simple law. T. M. L.

2472. *Power of Telescope.* **H. Moeller.** (Zeits. Instrumentenk. 45. pp. 384-387, Aug., 1925.)—Deals with intensity of the light and power of a telescope. W. H. Ge.

2473. *Testing of Binocular Telescopes.* **G. W. Moffitt** and **P. B. Taylor.** (Optical Soc. America, J. and Rev. Sci. Inst. 11. pp. 45–57, July, 1925).—The important point is the directly measured angle between the emergent beams when the incident beams come from a point at a distance equal to the average object distance in actual use. The new instrument described by the authors will test the adjustment of the optical axes, equality of magnification, leaning and relative leaning of the images, quality of imagery, width of field of view and errors of the reticule. The diagram shows the optical system of the new tester. Light from the illuminated reticules of the collimators passes through the binocular under examination to the corresponding objectives of the special observing telescope. The two full aperture beams are here united by means of suitable prisms and a semi-platinised mirror surface. This superposes the images, and a single eyepiece suffices. If the binocular is in accurate adjustment, the two images will be concentric, as indicated by the alignment of the radial line segments in the images. The construction and operation of the instrument are described and full details of the collimator given. T. C. H.



2474. *New Method of Constructing Large Telescopic Mirrors.* **G. W. Ritchey.** (Comptes Rendus, 181. pp. 208–210, Aug. 3, 1925.)—In co-operation with the Société des Glaceries of Saint-Gobain, the author has built up large discs by means of circular plate faces and rectangular compartments from very fine glass, specially annealed. These have been cemented so as to form very rigid circular discs of great solidity, but three or four times lighter than full discs of the same diameter. The thicknesses of the two trial mirrors of 75 and 150 cm. are 13 and 15 mm. respectively. The system of compartments is perforated so as to allow a free passage of air. The cement is a synthetic resin, known as bakelite, employed as a size which hardens if maintained for some weeks at 140°, acquiring good physical qualities, and less easily ruptured than the glass faces that it joins. Whilst being fired, it is subjected to considerable pressure by means of a metallic press. The 75-cm. mirror has been subjected to prolonged optical control, and shows itself to be of great

permanence. The 150-cm. mirror is under construction, but it is found that a thickness of 22 mm. would have been easier and more economical to work. A. S. D. M.

2475. *A New Type of Telescope especially adapted to Spectrometers.* **C. S. Hastings.** (Optical Soc. America, J. and Rev. Sci. Inst. 11. pp. 63-65, July, 1925.)—The relative dispersive powers of any two glasses selected for an achromatic combination vary from one end of the spectrum to the other; hence a completely achromatic doublet is impossible. The combination is generally made as closely achromatic as possible for the most important wave-length. In spectroscopic work, where no one wave-length is of the greatest importance, this defect is inconvenient. The author uses a new form of telescope with a constant focal distance for all wave-lengths, although the focal lengths are not invariable. A solution is given involving three lenses only, being the simplest and most easily tested. The necessary constants are given for the two types of glass generally used for telescopes. A temperature of 70° F. and a pressure of 30 in. may be assumed.

Line.	Type Flint.	Type Crown.
C	1·612917	1·516176
λ5614	1·620264	1·520163
F	1·629770	1·525098
G	1·640796	1·530556
h	1·646408	1·533246

The convention of indefinitely thin lenses being adopted, only the sums of the reciprocals of the radii for each lens have to be considered. These three values may be represented by A_1, A_2, and A_3, the algebraic sign of a radius being positive for a convex surface. Then, for the solution, $\log A_1 = 8{\cdot}72370$, $\log A_2 = 8{\cdot}91570$, $\log A_3 = 9{\cdot}21020$. The first and second lens are of type flint, the second being negative. The third is of type crown. Distance from first to second 20·5 in., second and third in contact. A short calculation shows that the focal length for the spectral line F is 30 in., with a focal distance of 9·5 in. from the third lens. The focal distances for the spectral lines in the table are, in order, + ·0017, + ·0005, + ·0000, + ·0006, + ·0015. If the auxiliary or correcting lenses are given a negative power in the collimator, its effective focal length may be much increased with small increase in tube length. The angular aperture of the collimator attached to a great telescope may then be easily reduced to the proper value without materially increasing the size of the spectroscope and a much wider slit may be used, thus yielding a spectrum free from longitudinal lines due to dust or imperfect edges of the slit. The author suggests the name orthokumatic for this system of telescopes. E. F.

2476. *Calculations for Correcting Lenses.* **A. Nectoux.** (Rev. d'Optique, 4. pp. 285–293, June–July, 1925.)—Mathematical treatment with numerical calculations and a graph. W. H. Gr.

2477. *The Caustics of Axial Point Objects.* **W. Merté.** (Zeits. f. Physik, 33. 7. pp. 533–546, 1925.)—The author obtains equations for the parameters of any caustic of a point object placed on the axis of an optical system, and by means of these determines the general properties of the caustics. When an integral rational function is chosen as the expression for the spherical aberration, results are obtained which are applicable in practice. The theory is applied to two examples, including the determination of the properties of a Zeiss-Tessar photographic objective. G. E. A.

2478. *Aberrations of Lenses of Short Focal Length.* **L. Lenouvel.** (Rev. d'Optique, 4. pp. 294–298, June–July, 1925.)—Continues the work of Part IV of a previous paper [see Abstract 2737 (1924)] and shows how a rapid test may be made of such lenses as are used for the photography of near objects. Reference is made to some similar recent work by V. Ronchi. W. H. Ge.

2479. *The Nichols Radiometer.* **J. D. Tear.** (Optical Soc. America, J. and Rev. Sci. Inst. 11. pp. 81–86, July, 1925.)—A summary, with bibliography, of the methods and progress of radiometry. [See Abstract 2031 (1924).] E. F.

2480. *Modification of Rayleigh Photometer.* **A. Blondel.** (Comptes Rendus, 181. pp. 310–312, Aug. 31, 1925.)—Deals with a modification of the Rayleigh photometer by which it can be used with a diffusing comparison surface. W. H. Ge.

2481. *Polarisation of Sodium Light.* **W. Kossel** and **C. Gerthsen.** (Ann. d. Physik, 77. 3. pp. 273–286, Aug., 1925.)—No polarisation could be found in the pure D-light excited by an almost parallel stream of electrons, there being no indication in the emitted light of the direction of motion of the exciting electron. The paper is illustrated with detailed diagrams of the experimental arrangements. W. H. Ge.

2482. *Scattering of Light by Dielectric Spheres.* **C. V. Raman.** (Zeits. f. Physik, 33. 10–11. p. 870, 1925.)—In connection with Blumer's work [see Abstract 1850 (1925)], attention is directed to two papers by Ray [see Abstracts 1122 (1922) and 1823 (1923)]. T. H. P.

2483. *Absorption Phenomena in Photo-electrically-conducting NaCl Crystals.* **Z. Gyulai.** (Zeits. f. Physik, 33. 4. pp. 251–260, 1925.)—By means of a photoelectric photometer, absorption measurements are made of light of different wave-lengths after passing through a quadratic crystal of NaCl. Monochromatic light from a source giving black-body radiation is employed. The spectral distribution of intensity after absorption is measured after transverse illumination of the crystal in the first place with light of long wave-length, and in the second place after intensive illumination with photoelectrically active blue-green light. The curve giving the absorption by the activated crystal of light of wave-lengths varying from 313 to 650 $\mu\mu$ shows a lowering of the absorption maximum compared with the non-activated, accompanied by an increase in absorption for the longer waves. A close parallelism is obtained in all cases between the curves for photoelectric sensitiveness and absorption.

The effect of light of long wave-lengths which restores the crystal to its original condition, and in an electric field allows the positive constituent of the current to flow, is related to quantum effects in light absorption. A long wave determined by $h\nu$ causes a positive current of the same magnitude as the negative current liberated by a short wave of dimensions $h\nu$. [See Abstract 1481 (1925).] J N. P.

2484. *Photochemical Potential Changes.* **K. Schaum** and **W. Schleussner.** (Zeits. wiss. Phot. 23. pp. 319–324, Aug., 1925.)—After outlining the general conditions of potential changes at a reversible electrode under the action of light, the authors discuss the Becquerel-effect proper, the higher Bohr-state resulting from the energy absorption by the photo-active molecules (or ions) according to $A_D + h\nu \rightarrow A_L$ (where D and L stand for darkness and light). With respect to the validity of Einstein's law of equivalence it is important to decide in each case whether the Becquerel-effect (B.E.) is real or only apparent. Recovery during darkness may also occur with photochemical reactions; the Bohr state should be re-established almost instantaneously, whilst the recovery is often slow. There is no recovery when the light reaction is quite irreversible and when autoxidation is excluded; permanent changes in the dark potential should therefore indicate the absence of several oxidation stages. Experiments with solutions of vanadium and uranium sulphates (not quite pure) were inconclusive; small quantities of foreign substances (notably H_2S) increased the B.E. upon which generally photochemical effects were superposed. In the reaction of Sasaki [Abstract 388 (1923)] the reversible light reaction predominates. When an illuminated electrode is coupled with a dark electrode, the current starting from the latter decreases to zero in a few hours; kept in the dark, the former electrode subsequently appears more positive owing to concentration changes, so that the current is reversed before the initial conditions are restored. H. B.

2485. *Silver in the Photograph.* **Lüppo-Cramer.** (Zeits. wiss. Phot. 23. pp. 294–302, Aug., 1925.)—This paper gives a general brief survey of the progress of the knowledge of the subject from 1848 to the present day. A list of the principal contributions to this branch of photographic information is appended. A. E. G.

2486. *Theory of Photographic Sensitivity.* **T. S. Price** and **S. O. Rawling.** (Nature, 116. pp. 281–282, Aug. 22, 1925.)—Since 1920 the knowledge of the formation of the latent image has been greatly increased by investigations which roughly divide themselves into three chapters. The first notable advance was made by Svedberg during the years 1920–22 and consisted in the proof that the latent image consists of small centres distributed on the silver halide grains of an exposed photographic plate, the distribution of the centres being entirely according to the law of chance. A grain is not developable unless it contains at least one such centre. The second step was to decide upon the origin of these development centres. Two theories were advanced. In one of these it was assumed that the light itself formed the centres, the grains themselves being supposed to be homogeneous. In the other it was assumed that there exist in the grains, prior to exposure, nuclei which are not silver halide and which are formed during the manufacture of the emulsion, and that the

action of light is to change their condition in such a way that they become centres at which development can start. The first theory was extensively investigated and modified by Silberstein and others, whilst the second was developed by Toy. Direct evidence in favour of the second theory was at length obtained by Clark. The third advance has recently been concisely summarised by Sheppard and deals with the nature of the nuclei postulated in the second theory mentioned above. The following theory of the nature of the nuclei has been arrived at. It is assumed that the action of light is to decompose the silver bromide into bromine and silver, and that the apparent sensitising action of a nucleus or "speck" is confined to increasing its size by accretion of photochemically reduced silver atoms until it is large enough to form a development centre. According to Sheppard, the formation of the "specks" is due to casual adsorption and reaction with the silver bromide of a substance present in the gelatin. The active substance has been found to be allyl isothiocyanate or allyl mustard oil. In the course of manufacture of a photographic emulsion, this substance reacts with the silver halide grains to give the silver sulphide specks. It is estimated that photographically active gelatin contains only about 1 part per 1,000,000 to 1 part per 300,000 of the sensitising substance. Other sulphur compounds are found to act in a similar manner, a necessary condition seeming to be that the sulphur must be doubly linked to another atom, and not singly linked to two other atoms. The analogous compounds of selenium and tellurium act in a similar way. [See also Abstract 1864 (1925).] A. E. G.

2487. *Energy Relations of Phosphorescence.* **F. Schmieder.** (Ann. d. Physik, 77. 4. pp. 381–416, Aug., 1925.)—Deals with the ratio of the energy of the emitted light to that of the light used to excite the phosphorescence or fluorescence. The work is founded on that of P. Lenard [Abstract 810 (1910)]. Many possible sources of energy were investigated and all assumptions were tested experimentally and were found to be justified. The experimental method was applied to three phosphorescent substances each of which was tested with light of two different wavelengths. The energy relations were found to be completely determined by the light quanta. The paper, which is illustrated by five diagrams and thirteen tables of results, should be consulted in the original.

W. H. Ge.

2488. *Polarised Fluorescence of Dyestuff Solutions.* **S. J. Wawilow.** (Zeits. f. Physik, 32. 10. pp. 721–729, 1925.)—Describes the use of the König-Martens spectro-photometer as a spectro-polarimeter. Shows that in a number of cases the degree of polarisation of the fluorescent light is independent of the wave-length throughout the fluorescence band. Solutions of fluorescein in water and in methyl alcohol show no measurable polarisation when the concentration is high; the measurements were difficult, as the extinction phenomena discussed by the author in a previous paper [Abstract 1638 (1925)], made the amount of fluorescent light very small, and the observations had to be made near the threshold of vision; the result was that scattered light below the threshold of vision was capable of disturbing the results, so that the measurements might easily indicate an appreciable percentage of polarisation when none existed, and no scattered light could be observed. The depolarisation of the fluorescence from fluorescein in glycerine and from erythrosine in water

when the concentration is increased was examined; in the former case the degree of polarisation p diminished from 38·5 % to 0·2 %; the diminution of p begins earlier than the extinction, and it is possible to conclude that not every collision between the dyestuff molecules which produces depolarisation produces extinction at the same time. H. N. A.

2489. *Polarised Fluorescent Light from Dyestuff Solutions.* **F. Weigert** and **J. Käppler.** (Zeits. f. Physik, 33. 10–11. pp. 801–802, 1925.)—Wawilow, in a recent paper [see preceding Abstract], does not confirm the observations of the authors on the increase of the polarisation of solutions of fluorescein in water with the concentration [Abstract 2735 (1924)]; they consider that the apparatus used by him did not give enough light for satisfactory observation, and that some extraneous light was measured. **Errata** (*ibid.*, 34. 1. p. 80, 1925). H. N. A.

2490. *The Theory of the Production of Fluorescence.* **A. Predwoditelew.** (Zeits. f. Physik, 32. 11–12. pp. 861–871, 1925.)—The work seeks to establish theoretically the connection between the production of fluorescence and the quantity C_v, which is the specific heat of the active molecules at constant volume and the work of dissociation of the molecule. Without the assumption of theoretical quantum hypotheses a method is deduced for the calculation of the mean energy of a resonator. A mathematical formula is finally deduced which is compared with the experimental results of S. Wawilow for fluorescein, rhodamin and eosin solutions. The agreement is remarkably good. S. G. B.

2491. *The Polarisation of Scattered and Fluorescent Light.* **L. Nordheim.** (Zeits. f. Physik, 33. 10–11. pp. 729–740, 1925.)—A theoretical treatise showing the disturbance of free atoms under the influence of waves of polarised light. The resulting conclusions are utilised for the elucidation of the theory of scattered and fluorescent radiation.

S. G. B.

2492. *The Quantum Theory of Aperiodic Processes.* **M. Born** and **P. Jordan.** (Zeits. f. Physik, 33. 7. pp. 479–505, 1925.)—*Part I.* This mathematical paper deals with the action of an aperiodic electric field upon a multiply periodic system, the investigation being made on the basis of the classical disturbance theory. It is shown how the formulæ therefrom developed are to be interpreted in correspondence fashion for quantum mechanics. Finally a correspondence principle of motion is established.

Part II. On the Integration of the Disturbance Equations. **P. Jordan.** (*Ibid.* pp. 506–508.)—A simplified but more rigid method of integration is developed for the disturbance equations of the above investigation which, in the author's opinion, will prove of service for other quantum problems. H. H. Ho.

2493. *The Impact of Light Quanta.* **K. Schaposchnikow.** (Zeits. f. Physik, 33. 9. pp. 706–709, 1925.)—It is assumed that the impact of two light quanta is perfectly elastic, and then by application of the method by means of which Boltzmann proved his H-theorem and also by adopting Wien's distribution function, the author concludes that a complete interchange of impulse takes place between two impacting quanta during

dark radiation. A complete analogy is obtained to the presentation from classical optics of the independent propagation of two different waves. The conclusions drawn do not contradict the Planck function.
H. H. Ho.

2494. *Relativistic Fine-Structure.* **G. Wentzel.** (Zeits. f. Physik, 33. 10–11. pp. 849–854, 1925.)—A mathematical discussion of the three quantum laws required to describe the structure of relativistic doublets and multiplets. F. S.

2495. *Relations of PP′ Groups in Atoms of the Same Electronic Structure.* **I. S. Bowen** and **R. A. Millikan.** (Phys. Rev. 26. pp. 150–164, Aug., 1925.)—(1) *For two-valence-electron atoms.* A quintuplet of nearly equally spaced lines (really an unresolved sextuplet) has now been found for all the two-valence electron spectra which have been studied by the method of hot-spark spectroscopy, namely for the series Mg_I, Al_{II}, Si_{III}, P_{IV}, S_V, Cl_{VI}, and for Be_I, B_{II}, C_{III}, N_{IV} and O_V. In both of these series, this pp' group has been definitely shown to arise from an electron jump from the lowest p to the lowest s orbit, combined with a simultaneous jump of the other electron between the p_1, p_2, p_3 orbits. The frequency differences between groups of successive atoms obey the irregular doublet law, showing that the jumps are between levels of the same total quantum number. (2) *For three-valence-electron atoms.* A new quadruplet pp' group has been discovered for all the atoms of this type studied, Al_I, Si_{II}, P_{III}, S_{IV}, Cl_V and C_{II}, N_{III}, O_{IV}. The relative intensity of this group increases with the effective nuclear charge, from Al_I to Cl_V. This group is proved to be due to the return of one of the s electrons after displacement to a p position combined with the simultaneous interchange of the p electron between the p_1, p_2 orbits. This group also obeys the irregular doublet law. These groups are of exceptional theoretical interest because their existence proves that the energy changes due to the simultaneous jumping of two electrons between orbits are integrated into monochromatic radiation. The mechanism by which such an integration takes place is at present a complete mystery. The ionisation potential must depend on the state in which the ionised atom is left after removing an s electron, for example, and will differ according as the p electron is left in the p_1, p_2, p_3 or P orbit.
Authors.

2496. *Optical Screening-Constant Regularities.* **A. C. Menzies.** (Phil. Mag. 50. pp. 414–422, Aug., 1925.)—Screening-constants have been calculated for the optical doublets and triplets of several chemical groups of atoms by application of the relativity doublet formula. In passing down a chemical sub-group of the periodic table the screening-constant S is found to vary directly as the atomic number Z. For many such sub-groups the change in S has approx. constant values in passing from one element to the next; for $Z = 8, 18, 32$; S is nearly 5, 13, 23 respectively. These numbers are shown to be of the order to be expected on simple considerations. The significance of the formula is discussed in the light of the probability that the origin of multiplets is magnetic rather than relativistic. H. H. Ho.

2497. *On the Red Displacement of Spectral Lines. A Note on Maneff's Paper "Gravitation and the Principle of Action and Reaction."* **K.**

Schaposchnikow. (Zeits. f. Physik, 33. 9. pp. 710–712, 1925.)—In current light quantum theory it is assumed that the impulse change of the light quantum is only conditioned by alteration of its frequency ν. Thereupon it follows that the impulse equation may be written as follows : $h/c\ d\nu/dt = F$. By application of the Newtonian gravitation law the above equation leads to the Maneff formula [see Abstract 1572 (1925)], which gives the red displacement of spectral lines. H. H. Ho.

2498. *Intensity of Spectral Lines.* **L. S. Ornstein.** (Phys. Soc., Proc. 37. pp. 334–347, Aug., 1925.)—The method heretofore adopted of measuring intensities of photographed spectral lines by means of Moll's registering microphotometer is described, and the necessary calibrations considered for the cases in which the lines to be compared are, or are not, sufficiently close for the plate to have the same sensitivity for each. It is then shown that certain ratios of intensity are to be expected for the components of various multiplet series according to Sommerfeld and Landé's extension of Bohr's theory. Comparison with experimental results is made for a number of cases. F. S.

2499. *The Effect of Darkening due to Absorption of Radiation on the Output of Light from Luminous Bodies with Coiled-Wire Filaments.* **E. Lax** and **I. Runge.** (Zeits. techn. Physik, 6. 7a. pp. 317–322, 1925.)—The subject is first treated theoretically and expressions derived which are then applied to practical values. Theoretically a deterioration of light output of 10 % should ensue. It is found, however, that comparison of theory with experimental results is difficult on account of large sources of error found in practice. No definite conclusions can be drawn for ordinary glow lamps from the theoretical formula given, since a large number of other factors have also to be considered, such as, *e.g.* diminution in the number of supports, use of thicker wire, etc. S. G. B.

2500. *Spark Spectra in the Schumann Region.* **L.** and **E. Bloch.** (J. de Physique et le Radium, 6. pp. 105–120, April, and pp. 154–165, May, 1925.)—A new instrument has been constructed in which the fluorite is practically colourless and free from fluorescence, but it is of smaller aperture. This has been used for the region 1950 to 1500 Å., and many more lines have been found than formerly when a fine slit was used. New standard wave-lengths have also been adopted, so that higher accuracy is expected. Tables of wave-lengths and intensities are given for the spark spectra in nitrogen of iron, nickel, cobalt, tungsten, manganese, chromium, copper, silver, gold and platinum. F. S.

2501. *Irregular Zeeman-Effects in Multiplets of the First Order.* **E. Back.** (Zeits. f. Physik, 77. 8. pp. 579–600, 1925.)—The author describes the results of observations which show that, for certain groups of lines of the calcium spectrum belonging to the system of " new terms " which has recently been discovered and explained by Russell and Saunders in the spectra of the alkaline earths, Landé's formula for g, the separation factor, does not hold, and that the same is true of the selection principle obeyed in the case of ordinary lines for the equatorial quantum number m. The values of g for the terms $1f_4''$, $1f_3''$ and $1f_2''$ are 5/4, 13/12 and 3/4, and for the term $1x_{(2)}$ the value is 8/9 ; the value for f_2 terms according to the rule is 2/3, so both the $1f_2''$ and $1x_{(2)}$ values are irregular. It is to

be noted, however, that the product of these values 3/4 and 8/9 is equal to the regular value of g, 2/3; and the f_2'' and $x_{(2)}$ terms must be regarded as of a similar nature, *i.e.* as irregular f_2 terms which complete one another as above to the regular f_2 term with $g = 2/3$. It is also shown by means of a table and a diagram that in the case of certain multiplets of magnesium a number of lines which are to be expected according to the ordinary selection principle are missing; that is to say, in certain cases in the combination $p_i d_i$ (triplets) the passages from or to $m = 0$ and p_1, which according to the ordinary rule are allowed, are forbidden; all others are unaffected. Similar observations have been made for calcium and for sodium (partial Paschen-Back effect). H. N. A.

2502. *The Zeeman-Effect in Strong Magnetic Fields.* **P. Kapitza** and **H. W. B. Skinner.** (Roy. Soc., Proc. 109. pp. 224–239, Sept. 1, 1925.)—Apparently no measurements have previously been made of the Zeeman-effect in fields stronger than 40,000 or 50,000 gauss. The authors have employed a method previously described by Kapitza [Abstracts 2967 (1924) and 375 (1925)], in which a field strength up to 500,000 gauss is obtained by passing a large current through a coil without iron for a very short time, so that the coil has not time to heat up. Since for the study of the Zeeman-effect the field must be uniform over the volume in which the source of light is placed, it is only possible to work up to 130,000 gauss. The magnet switch and the spark switch were mechanically connected and adjusted, so that the spark occurred during the short time during which the current and therefore the magnetic field remained uniform, about 1/300 sec. The spectrum was photographed using a high dispersion quartz spectrograph, and the plates were measured photometrically. The splitting of the lines was found to be approximately what would be expected from the usual experiments, if the separations are proportional to the field strength. With the triplet $p - s$ combinations of Zn and Hg, however, there is evidence that the splitting is not strictly proportional to the field between 70,000 and 130,000 gauss, being 10 % greater than expected in the latter case. The splitting of the $s - p$ combinations in doublet and singlet spectra appears to be normal. A suggested explanation is given. Cases of the Paschen-Back effect have been observed and are discussed. H. N. A.

2503. *Order of Appearance of Spectrum Lines.* **F. L. Brown** and **J. W. Beams, Jr.** (Optical Soc. America, J. and Rev. Sci. Inst. 11. pp. 11–15, July, 1925.)—The double refraction of carbon disulphide in an electric field was used to measure the short time intervals, but the apparatus as previously used by other workers was modified so that a spark could be used directly in front of the device. The time interval between the spark and the operation of this shutter was varied by moving a cross piece along long parallel wires. For cadmium the order of appearance is 5378 and 5337, 4800, 5086 and 4678, 6438, and for magnesium 4481 doublet and then 5184, 5172 and 5167 triplet. Thus spark lines are emitted before arc lines. A mirror device was introduced for actual measurement of time intervals which are of the order of 10^{-8} sec. F. S.

2504. *Infra-red Band-Spectra.* **H. Deslandres.** (Comptes Rendus, 181. pp. 265–271, Aug. 17, 1925.)—In this continuation of previous work [see Abstract 2274 (1925)] the author considers the band-spectrum

of NH_3 in a similar manner to that employed before for water-vapour. Secondary maxima are found to have an interval proportional to one-seventh of the frequency 1062·5, while the intervals for water-vapour are proportional to one-eighth of the same number. These denominators are identical with the atomic numbers of the heavier atom in the molecule. The secondary maxima for HF, HCl and HBr are then considered, denominators of 9 and 17 being found for F and Cl, while for Br the number 35 is found. F. S.

2505. *Arc Spectrum of Nitrogen.* **C. C. Kiess.** (Optical Soc. America, J. and Rev. Sci. Inst. 11. pp. 1–9, July, 1925.)—The regularities previously observe din the infra-red spectrum of nitrogen [see Abstract 1385 (1925)] have now been compared with the results of Merton and Pilley in the visible, and a number of identical wave-number differences found. Several quartet multiplets have been traced and also some doublets with $\Delta\nu = 83{\cdot}12$. There is a discrepancy between this separation and that found by Hopfield and Leifson in the extreme ultra-violet. F. S.

2506. *Production of Atomic Nitrogen and its Arc Spectrum.* **K. T. Compton.** (Phil. Mag. 50. pp. 512–516, Sept., 1925.)—It has been found impossible to thermally dissociate molecular nitrogen by the method given elsewhere [see Abstract 1170 (1924)]. The possibility of dissociating it by collisions of the second kind with excited atoms of helium is discussed. Recent experiments of Merton and Pilley relating to the spectrum of nitrogen are also discussed. W. H. Ge.

2507. *The Flame Spectra of Carbon Monoxide and Water-Gas. Part I.* **F. R. Weston.** (Roy. Soc., Proc. 109. pp. 176–186, Sept. 1, 1925.)—A systematic investigation of the flame-spectra of carbon monoxide and of mixtures of carbon monoxide and hydrogen under various conditions in order to elucidate certain aspects of the combustion of carbon monoxide. It is concluded that in a flame of pure (undried) CO two sets of independent interactions occur simultaneously, namely (*a*) direct interaction between CO and oxygen, exciting radiations which gives rise to the continuous and banded parts of the spectrum and to the characteristic blue colour of the flame; and (*b*) interactions between CO and H_2O molecules which orignate the "steam lines" in the spectrum. When hydrogen is gradually added to the burning gas, the relative proportions of the first-named interactions diminish rather rapidly, and proportionally more of the CO is burnt by interaction with H_2O molecules until, when an equi-molecular mixture of carbon monoxide and hydrogen is reached, the CO and H_2O interactions occur to the practical exclusion of the CO oxygen interactions. W. V. M.

2508. *The Absorption Spectrum of Lead Vapour in the Ultra-violet.* **R. V. Zumstein.** (Phys. Rev. 26. pp. 189–194, Aug., 1925.)—Using a column of vapour about 3 cm. long in a carbon tube at various temperatures up to 1600° C., absorption was found at 34 lead lines, of which 20 are new. The results may be interpreted very well on the basis of the energy diagram given by Thorsen and Grotrian. Absorptions were observed only from the normal state $2p_4$ and the metastable states $2p_3$ and $2p_2$. The introduction of the $2p_5$ state does not seem to be necessary. Additional combinations have been found with the terms X_1 and X_2.

A new term X_3 (10,232) is proposed. Values are suggested for the terms $3p_2$, $3p_3$, $4p_2$, $4p_3$. Evidence is given for interchanging the terms $3d_1$ and $3d_2$ and for a new series ($2p_3 - mx$). The spectrum of a 100-ampere Pb arc was photographed to 2000 Å. and three new lines measured. The line 2070 Å. may be due to silver and 2189 Å. seems certainly to be due to lead and not to bismuth. AUTHOR.

2509. *Multiplets in the Spectrum of Ionised Vanadium.* **W. F. Meggers.** (Zeits. f. Physik, 33. 7. pp. 509–528, 1925.)—Tabulated data of optical measurements of multiplet lines in the spark-spectra of vanadium are given. B. J. L.

2510. *On the Spectrum of Ionised Calcium (Ca II).* **F. A. Saunders** and **H. N. Russell.** (Astrophys. J. 36. pp. 1–7, July, 1925.)—Results are given of measurements of the spectrum of Ca II from various sources, showing the existence of a system of combination series of the same sort as occur in Mg II. The second and third members of the principal series have been found, and series of the types $2\pi - m\sigma$, $2\pi - m\delta$, and $3\phi - m\phi'$ detected, together with other combinations. Tables of all the series and combinations and of the term-values and Rydberg denominators are included. AUTHORS.

2511. *The Absorption Spectra of Mixed Metallic Vapours. II. The Spectra of Volatile Compounds of Magnesium and the Alkali Metals.* **S. Barratt.** (Roy. Soc., Proc. 109. pp. 194–197, Sept. 1, 1925.)—In a previous communication [Abstract 1167 (1924)] a band system has been described found only in the absorption spectrum of mixed vapours of Na and K. Bands analogous in origin—*i.e.* molecules of a volatile compound of the two metals—have been found in the absorption spectra of mixtures of the vapours of Mg and alkali metals. Early experiments of Liveing and Dewar have been amplified and absorption also found in mixtures of Mg with rubidium and cæsium. Spectra corresponding to Mg-Na, Mg-K, Mg-Rb, Mg-Cs are described. It is impossible to determine the molecular formula of the compounds responsible for the absorption spectra from the present results, but photographs using higher dispersion might help. W. V. M.

2512. *Ultra-red Absorption Spectra. Experimental and Theoretical Determination of the Ultra-red Absorption Spectra of some Organic Substances.* **L. Márton.** (Zeits. phys. Chem. 117. pp. 97–128, Aug. 10, 1925.)—Experimental apparatus to measure ultra-red absorption band-spectra is described and its precision discussed. By this apparatus measurements of absorption band-spectra were made from the visible region to 4 to 5 μ on hexane, cyclohexane and its homologues, benzene and its homologues, aliphatic aldehydes and ketones, chloroform, phosgene and thiophosgene.

Experimental data are given. These absorption spectra are considered in relation to chemical constitution and the following results obtained: (1) The closure of chain to ring bodies is attended with a displacement of bands towards the region of greater wave-length and an increase of intensity. (2) Homologues are chiefly differentiated by the band intensity, the position being fixed. The only characteristic of the spectra is the variation of the chief bands from one to another when passing from

low to high homologues. (3) Unsaturated compounds give a wave-length displacement towards the violet. It was attempted to arrange many of the measured bands as harmonics in accordance with the theory of band-spectra. The position of the band corresponds with a non-harmonic oscillation of the molecule, which can be very exactly represented by $\nu_s = p\nu_0(1 - px)$. For a number of substances values of ν_0 and x are given and the calculated values compared with the experimental values of the present and other experimenters. The paper contains the mathematical treatment, from first principles, of the theory of band-spectra, based upon the Balmer and Deslandres hypotheses and considering the "fine structure." B. J. L.

2513. *A Universal X-Ray Spectrograph.* **A. Müller.** (Journ. Sci. Instruments, 2. pp. 312–318, July, 1925.)—The paper is divided into sections dealing with (1) the Laue theory of the diffraction of X-rays by crystals, (2) the Bragg method of crystal analysis, (3) a description of the various procedures in crystal analysis which are based on the Bragg method, (4) varieties of X-rays, (5) application of X-ray spectrography, (6) quantitative estimations of the presence of an element by X-ray methods. A detailed description of a universal X-ray spectrograph is given. The paper is illustrated by photographs obtained by the different methods described. E. G.

2514. *The Compton-Effect.* **G. Wentzel.** (Phys. Zeits. 26. pp. 436–454, July 21, 1925.)—First instalment of a full *résumé*. This instalment comprises: Introduction; wave-length alterations; the quantum theory (Compton, Debye); the semi-classical theory (Försterling, Halpern and others); dualistic theories (Bohr, Kramers, Slater); testing the theories by reaction electrons; problems of intensity, its distribution in scattered radiation; scattering and the absorption coefficient; distribution of velocities of reaction electrons. To follow: models and applications. A. D.

2515. *Braked-down Radiation and Compton's Scattered Radiation.* **G. Mie.** (Zeits. f. Physik, 33. 1–2. pp. 33–41, 1925.)—The light-emission theory of Bohr, Kramers and Slater explains braked-down X-radiation if the free electrons can also take up different internal conditions, if they in all higher-valued conditions radiate according to the Bohr $h\nu$ law, and if the radiation from them is nil only in the most stable conditions. The retarded radiation is caused by shocks of the first kind which excite the free electrons of the kathode rays. Compton's scattered radiation is the fluorescence-radiation of free electrons excited by optical resonance. If they radiate without disturbance, they give reaction electrons; if they encounter shocks of the second kind, they give the rapidly moving photoelectrons. A. D.

2516. *Precision X-Ray Measurements by the Powder Method.* **F. C. Blake.** (Phys. Rev. 26. pp. 60–70, July, 1925.)—Spectrograms were obtained with a semi-cylindrical camera of radius 16·65 cm. giving lines on both sides of the undeflected beam, using a powder sample about 0·2 mm. in radius held in an accurately centred hole. Correction for film shrinkage was made by using Al as a comparison. Correction for penetration into the sample: This is taken to cause a shift of each line δl

equal to $d \cot \theta$, and a value of d is chosen so as to make the lattice constant a_c, computed from the various lines, approximately the same, or if the constant is assumed known, as in the case of Al, to make the computed radius come out constant. In one test with Fe the greatest variation from the mean a_c was only 0·1%, taking d as 0·006 cm. With samples of varying radius r, the value of d was found to vary from + 0·006 cm. ($r = 0{\cdot}15$ mm.) to − 0·014 ($r = 0{\cdot}72$ mm.). Hadding's method of correction is discussed. It is suggested that a combination of the two methods, taking $\delta l = K_1\theta \cot + K_2 r$, would give even more accurate results. Lattice constant for pure iron is found to be 2·8603 ± 0·0002 Å. AUTHOR.

2517. *The Distribution of Intensity in the X-Ray Spectra of Certain Long-chain Organic Compounds.* **G. Shearer.** (Roy. Soc., Proc. 108. pp. 655–666, Aug. 1, 1925.)—Recent X-ray spectroscopic investigations have allowed the actual orientation of organic molecules to be determined. These fall into two groups: (*a*) Those whose lattice planes are separated by the length of a single molecule, (*b*) those in which the spacing corresponds to the length of two molecules. The end-to-end arrangement in the latter case appears to be dependent upon certain chemically active groups, as acid or hydroxyl radicles. The arrangement of the former grouping depends upon neutral terminations, as in esters, ketones, etc. The author develops a mathematical theory in which the second arrangement should lead to suppression or loss of intensity of certain orders of X-ray spectra—for example, the spectra decrease progressively in the case of hydrocarbons from the spectra orders one to nine—whereas in the case of alcohol, acids and haloids, in addition to the general decrease of intensity with order, there is a tendency to suppression of the spectra of odd orders. Many calculated and observed values are given and serve to confirm the theory. The methods suggested are of importance upon chemical grounds, as they would serve to determine the positions of certain radicle groupings by X-radiation methods when normal chemical methods are unavailable. B. J. L.

2518. *X-Ray Terms and Intensities.* **H. R. Robinson.** (Phil. Mag. 50. pp. 241–250, July, 1925.)—The experiments described are a continuation of those in a previous paper [see Abstract 868 (1924)], where full experimental details may be found. Using copper $K\alpha_1$ as primary X-radiation, the electron groups from the following elements have been measured: Uranium (oxide), thorium (nitrate), gold (leaf), arsenic (oxide), manganese (oxide), titanium (oxide); the complete results are tabulated. It is found that the general nature of the distribution of intensity among sub-groups follows closely the lines indicated in the author's earlier paper. The present set of observations show that so long as the critical absorption frequency of a group is not too far removed from the frequency of the incident radiation most of the secondary electrons emitted come from the "softer" sub-groups. A. B. W.

2519. *The Energies of Multiple X-Ray Ionisation of Light Atoms.* **L. A. Turner.** (Phys. Rev. 26. pp. 143–149, Aug., 1925.)—The assumption is made that the removal of a K electron has the same effect on the energies of the outer electrons of the atom as the increase of the nuclear

charge by one unit. The energy for the successive removal of a K electron and an L electron is computed for elements Na to K on this basis. By means of Wentzel's theory and Hjalmar's measurements of the K spark lines α_3, α_4, α_5, α_6, other multiple ionisation levels are computed for the elements Na to S. The square roots of the energies ($\sqrt{\nu/R}$) for the successive removal of the first, second and third L electrons plotted against atomic numbers give three parallel straight lines, indicating that the removal of the first L electron reduces the screening constant (7·27) for the remaining ones by 0·62, and that the removal of the second one causes a further reduction of 0·65. Similar lines are obtained for the two K electrons, the screening constant (1·5) being reduced 0·16 by the removal of the first one. The energies for the successive removal of two electrons from a helium-like ion made up of a nucleus of charge Z and two electrons are computed for these atoms. The plot indicates that the experimental value of the K absorption limit of phosphorus is in error.

AUTHOR.

2520. *The $K_{\alpha 1,2}$ Doublet of the Light Elements and the Dependence of the X-Ray Spectrum upon Chemical Combination.* **E. Bäcklin.** (Zeits. f. Physik, 33. 7. pp. 547–556, 1925.)—This paper is largely tabular and deals with precision measurements of the $K_{\alpha 1,2}$ doublets from atomic number N = 13 to 20, *i.e.* Al, Si, P, S, Cl, K and Ca. No effect of chemical constitution was found for Al_2O_3, SiO_2, P_2O_5, K_3AlO_3, Na_2SiO_3 and Na_3PO_4. With sulphur, as S, $CuSO_4$, $MgSO_4$, K_2SO_4 and $BaSO_4$, in the case of the element only a doublet was present, but in the combined state this was resolved into a triplet, indicating the dependence upon chemical combination. B. J. L.

2521. *A Simple Experiment to Obtain Selective Effects in the Dispersion of X-Radiation.* **H. Mark** and **L. Szilard.** (Zeits. f. Physik, 33. 9. pp. 688–691, 1925.)—A method is described to permit the detection of abrupt variations in X-radiation refraction. This depends upon no reflection of the first order occurring from the octahedral (111) plane of RbBr, as both atoms are equally dispersive. Reflection does, however, occur when this equality is abruptly varied, due to selective absorbtion by either atom. Such abrupt variations were found to occur in experiment, for example, when the strontium K-radiation is reflected, with selective absorption due to the Rb ion. B. J. L.

2522. *A New K_β Doublet of Manganese and Chromium.* **N. Seljakow** and **A. Krasnikow.** (Zeits. f. Physik, 33. 8. pp. 601–605, 1925.)—Hjalmar [Abstract 914 (1922)] has shown that the K_{β_1} line is a doublet up to elements as high as copper. The present authors, by means of a precision Siegbahn spectrometer, have shown the presence of this doublet in elements of higher atomic number. For iron the doublet was only obtained in one of ten exposures. For manganese the doublet is easily obtained. For chromium the doublet is present but difficult to show, and for titanium no doublet was obtained. Spectroscopic details of measurements are given. B. J. L.

2523. *On the Refractive Powers of Atoms for X-Radiation.* **H. Mark** and **S. Tolksdorf.** (Zeits. f. Physik, 33. 9. pp. 681–687, 1925.)—Tabulated results are given of spectral measurements made with a cubical

crystal of anhydrous strontium chloride of grid constant 7·00 Å. From the intensities of the resultant interference lines for the K-radiation of Zn, Fe, and Cu it is concluded the refractive power of the ions is not simply proportional to the atomic numbers. B. J. L.

2524. *Application of X-Rays for the Identification of Various Substances, and, in particular, Natural Pearls.* **A. Dauvillier.** (Soc. Franç. Elect., Bull. 5. pp. 215–229, March, 1925.)—For chemical and other analyses two methods, dependent upon absorption and diffraction respectively, are available. Illustrations are given, with particulars of suitable apparatus, for the detection of the constituents of mixtures of rare earths and of the detection of the nucleus in artificially cultivated pearls. Representative spectrographs are given. B. J. L.

2525. *J Phenomena in X-Rays.* **C. G. Barkla.** (Phil. Mag. 49. pp. 1033–1056, May, 1925.)—A brief general account of the J absorption discontinuities observed by Barkla and White and by Barkla and Stevens. As the penetrating power of the radiation is increased, either by increasing the voltage of the X-ray tube or selecting the characteristic radiations from elements of increasing atomic number, or finally by filtering out the soft rays, sudden increases occur in the absorption by a particular substance. The observations are very difficult, since the phenomena are by no means always repeated under apparently identical conditions. The discontinuity is much more closely associated with a definite value of the absorption coefficient than with a wave-length. With aluminium the sudden change takes place for $\mu/\rho = 0{\cdot}7$ under a number of different conditions where the constitution of the X-ray beam is by no means identical, for oxygen at $\mu/\rho = 0{\cdot}82$, and for copper at $\mu/\rho = 0{\cdot}6$. In addition to these J_3 absorption steps J_2, J_1, J_4 and J_5 steps have been observed. Frequently only the filtered radiation shows the discontinuity; this indicates that it is due to a change in the properties of the radiation produced by transmission through matter. The change of critical absorption coefficient with atomic number is very small, and diminishes with increasing atomic number, $\mu/\rho(J_3) = 0{\cdot}57$ for Pt and $0{\cdot}54$ for Au. The series of critical absorption coefficients cuts right across the K series. H. N. A.

RADIO-ACTIVITY.

2526. *The Forces acting in Nuclear Collisions and Coulomb's Law.* **H. Pettersson.** (Ark. f. Mat. Astron. och Fysik, Stockholm, 19b. No. 2. pp. 1–6, 1925. In English.)—Assumes that when an α-particle comes close to the nucleus of some heavier atom, made up of a certain number of protons and electrons, the nucleus is polarised, the electrons being somewhat displaced towards the α-particle and the protons away from it. The problem is treated as though the nucleus were a spherical conductor and the α-particle a point charge brought near it, and it is shown that the force F between the sphere and the point becomes zero for a definite distance R_0 between the point charge and the centre of the sphere; at distances less than R_0 the force is attractive, and varies approximately inversely as the fifth power of R. It does not appear necessary to assume with Rutherford and Chadwick that positively charged bodies attract one another when the distance between them becomes very small. It is

claimed that the two assumptions of the satellite hypothesis (that only a few atomic nuclei, supposed to have a peculiar structure, are disintegrable, and that the total number of H-particles ejected is only a small fraction of the number of nuclear hits) are contradicted by experiment. The author's explosion hypothesis is explained. H. N. A.

2527. *A Proposed Model for the α-Particle and some Nuclear Series.* **R. Hargreaves.** (Phil. Mag. 50. pp. 470–491, Aug., 1925.)—The author's primary series (i) of nuclear models is a triplane distribution. In the upper and lower of three equidistant parallel planes positive electrons describe equal circles; in the middle plane the negative electrons describe a circle of smaller radius; the centres of the circles are on a common axis perpendicular to the planes. Each circle has n elements equally spaced, + above + and − half-way between in azimuth with a common angular velocity for all particles. In the model of the α-particle the four positive electrons lie at the four corners of a rectangle, the two negatives at the ends of a perpendicular to the rectangle through its middle point; the axis of rotation passes through this point, parallel to the shorter sides of the rectangle. Numerical solutions have been found for $n = 2$, 3 and 4, and an extension to $n = 20$ is suggested as possible. In series (ii) a negative is added at the centre of the system. The position of this electron is unstable for small values of n and stable for higher values. This electron helps to hold the protons, and ω^2 apparently vanishes for $n = 24$, and the highest value for the atomic weight may be 48. In series (iii) there are two negative electrons on the axis at equal distance from the centre. The main term in the value of ω^2 vanishes for a value of n between 26 and 27, perhaps including the latter value. For higher atomic weights a double ring with m positive elements outside and m negative elements inside is supposed to be placed in the central plane inside the main structure. H. N. A.

2528. *Influence of Magnetic Fields on the Stopping-power of Gases for α-Particles.* **R. de L. Kronig.** (Cambridge Phil. Soc., Proc. 22. pp. 773–776, July, 1925.)—The author determines mathematically the influence of space quantization on the assumptions underlying the theory of the stopping of α-particles by matter. Reference is made to the work of Bohr [Abstract 1720 (1915)] and of R. H. Fowler [see next Abstract] on this subject and extends it to include space quantization produced by a sufficiently strong magnetic field. A. B. W.

2529. *Stopping-power of Hydrogen Atoms for α-Particles.* **R. H. Fowler.** (Cambridge Phil. Soc., Proc. 22. pp. 793–803, July, 1925.)—At the suggestion of N. Bohr the author has calculated the mechanical transfer of energy from an α-particle to an electron moving in its normal circular orbit in a hydrogen-like atom. This calculation is recorded in the present paper. A short abstract is not possible. A. B. W.

2530. *Alpha-Rays from Polonium. Fluctuations in Range, Speed of Emission and Ionising Power.* **Irène Curie.** (Ann. de Physique, 3. pp. 299–401, May–June, 1925.)—The experimental facts emerging from the author's investigation are as follows: (1) The distribution of range of the α-particles emitted from polonium in air conforms to a law of probability, with a small excess of short-range particles. The differences

of range of the particles does not exceed 3 mm. in air at 15° C. and 760 mm. pressure, contrary to the results obtained by the method of scintillations. (2) The initial velocity of the α-rays from polonium is $1{\cdot}593 \times 10^9$ cm./sec. The homogeneity of velocity has been verified to 3 % approx. (3) The form of the ionisation curve has been found to be a little different from that which is generally supposed; the final fall is not rectilinear, but slightly concave. The range extrapolated is 3·87 cm. in air at 15° C. and 760 mm. (4) The variation of ionisation along the track of the α-particle has been deduced from the ionisation curve and the distribution of range of the particles; the curve which represents this variation differs but slightly from the Bragg curve. The maximum occurs 4·5 mm. approximately from the end of the range. A. B. W.

2531. *Magnetic Spectrum of β-Rays from RaE.* **Irène Curie** and **J. d'Espine.** (Comptes Rendus, 181. pp. 31–33, July 6, 1925.)—The principal band of β-rays from RaE is found to be very sharply defined on the side of high velocity for $\beta = 0{\cdot}936$, and is less perfectly defined on the low-velocity side towards $\beta = 0{\cdot}70$. The band appears to be double, one band extending from $\beta = 0{\cdot}936$ to $\beta = 0{\cdot}80$, whilst the other, less well defined, extends from $\beta = 0{\cdot}86$ to $0{\cdot}70$. A very feeble radiation is noted at $\beta = 0{\cdot}50$. The results are tabulated as follows:—

	$H\rho$.	β.	V, energy in volts.
1. Group of lines or faint band	10,000 to 7000	0·986 to 0·97	2,500,000 to 1,700,000
2. Principal band:			
Strong	4500	0·936	936,000
Very strong	2900	0·86	500,000
Stronger still	2240	0·80	340,000
3. Traces of radiation	1640 to 1000	0·70 to 0·50	200,000 to 80,000

A. B. W.

2532. *Experiments on Absorption and Scattering of γ-Rays.* **N. Ahmad.** (Roy. Soc., Proc. 109. pp. 206–223, Sept. 1, 1925.)—The absorption of γ-rays from RaB + C, hardened progressively with filters made of different thicknesses of iron, of lead and of mercury, by Al, Cu, Sn and Pb has been measured; a modified form of balance method was employed. For each of these elements the atomic absorption coefficient μ_a is expressed by the formula $\mu_a = AZ + BZ^4$, where A and B are constant for a particular beam, but decrease as the γ-rays become harder. The terms AZ and BZ^4 represent respectively the scattering and the fluorescent absorption, so that the absorption of the γ-rays follows the same general law as that of X-rays of much lower frequency. The mean effective wave-length of the beams, deduced on Compton's theory from the scattering term, agrees very well with that deduced on the λ^3 law from the fluorescent absorption term. It seems probable from the measurements that the homogeneous γ-rays γ_1, γ_2, γ_3, γ_4 and γ_5 from RaB + C are superimposed on a background of general γ-radiation, containing a considerable fraction

of the total γ-ray emission, with a maximum at about 0·02 Å. Using an ionisation chamber capable of revolving about the radiator (absorber), the intensity of scattered rays has been measured; the observed values are from one-third to one-fifth of those predicted by the classical theory, but agree fairly well with Compton's formula. H. N. A.

2533. *The Heating Effect of the γ-Rays of Radium B and Radium C.* **C. D. Ellis** and **W. A. Wooster.** (Phil. Mag. 50. pp. 521–536, Sept., 1925.)—The apparatus consisted of a solid cylinder, with an axial hole, divided into three quadrantal parts, one of lead, the opposite one of aluminium and the intermediate ones of Balsa wood. The aluminium sector had holes bored in it, so as to make its heat capacity the same as that of the lead sector, and silver constantan thermocouples were wound round the cylinder, with alternate junctions on the lead and on the aluminium. A copper tube was placed in the central hole, and a small glass tube filled with radium emanation inside this. The α- and β-rays were absorbed by the copper and heated it, heat being conveyed to the lead and the aluminium sectors in equal amounts, causing no deflection of the galvanometer. Very few γ-rays were absorbed by the aluminium, and nearly all by the lead, the difference in temperature between the sectors being due to the difference between these two energies. Various corrections are discussed, and the result obtained that the amount of radium B and radium C that is in equilibrium with 1 gramme of radium emits 8·6 calories per hour in the form of γ-rays; of these it is calculated that 0·86 cals. are due to RaB and 7·7 to RaC. The result is in general agreement with Kovarik's conclusion that on the average two γ-rays are emitted for every two disintegrations, one of radium B and one of radium C. H. N. A.

2534. *Radio-active Springs at Guergour, Algeria.* **I. Pouget** and **D. Chouchak.** (Comptes Rendus, 181. pp. 124–126, July 20, 1925.)—Gives the radio-activity in millimicrocuries of radon per litre for ten neighbouring springs; this varies from 122 down to 4·9, the first spring being among the most radio-active springs known, coming after Joachimsthal (240) and a spring in Ischia (194). H. N. A.

2535. *The Radio-activity of the Contrexéville Springs.* **L. Jaloustre, G. Danne, M. Demenitroux** and **A. Maubert.** (Comptes Rendus, 181. pp. 222–224, Aug. 3, 1925.)—The *Source du Pavillon* contains 0·85 millimicrocuries of radium emanation per litre, and as a maximum 0·50 millimicrogrammes of radium. For the *Source du Quai* the corresponding numbers are 2·50 and probably about 0·33. This is the first determination made for this spring. H. N. A.

HEAT.

2536. *Thermal Expansion in Crystals and Chemical Constitution.* **F. A. Henglein.** (Zeits. Elektrochem. 31. pp. 424–428; Disc., 428, Aug., 1925. Paper read before the Deut. Bunsen Gesell., Darmstadt, May, 1925.)—This paper forms part of a systematic investigation and continues previous work on spatial arrangements in crystals. The experiments now described concern the thermal expansion of the alkali halides within the range — 184° to room-temperature. The present choice was made because the crystalline structure is simple and the physico-chemical data of the alkali metals fairly well established. Experimental determinations of the densities were made at a series of temperatures within the above range by means of apparatus already briefly described [see Abstract 1919 (1925)] and now discussed at greater length. The expansion coefficients were then evaluated. It is noteworthy that no sudden changes of density were encountered, indicating absence of modification changes. With each salt the expansion coefficient decreases with falling temperature. At the same temperatures, salts with the same kation show increased expansion coefficients with increasing atomic weight of the anion, and with the same anion decreased expansion coefficients with heavier kations, the fluorides alone proving an exception. Of all the salts examined lithium iodide possessed the greatest and lithium fluoride the smallest expansion coefficient. In general the chlorides and bromides are much nearer than the iodides and fluorides. The heats of formation change in the same manner as the expansion coefficients. A discussion of mixed crystals is included, these forming a transition from physical mixture to chemical compound. The remarks of Tammann, Herzfeld and the author are reported. H. H. Ho.

2537. *A Quartzglass Apparatus for the Estimation of the Coefficient of Expansion by Heat at High Temperatures.* **V. Sieglerschmidt.** (Zeits. Instrumentenk. 45. pp. 374–378, Aug., 1925.)—A note on the construction of an electrically heated oven adapted for the determination of coefficients of expansion of rods of various materials up to 450° C. The paper is an addendum to a previous note on the substitution of an air bath for liquid baths for heating purposes. The actual expansion is recorded by a telescope and eyepiece some distance away from the instrument. The rod under test is placed between two quartz slabs, the lower one of which rests on a pointed quartz rod and the upper one carries the apparatus for the determination of expansion. This is described in detail with diagrams showing the intimate parts, whilst a photograph shows the method of use of the apparatus. A table is given showing results of experiments on brass rods up to 450° C. S. G. B.

2538. *A Flow Calorimeter for Specific Heats of Gases.* **N. S. Osborne, H. F. Stimson** and **T. S. Sligh, Jr.** (Bureau of Standards, Sci. Papers No. 503. pp. 119–151, 1925.)—Describes in detail the construction of a flow calorimeter of small heat capacity which is suitable for measuring specific heats of gases over a wide range of temperature and pressure. The flow is maintained constant by automatic control of the pressure of

gas entering the calorimeter and protection of the discharge from pressure variations in the condenser. The corrections for pressure drop through the calorimeter and for thermal leakage are determined from supplementary experiments. The apparatus has been employed to investigate the variations with pressure and temperature of the specific heat of ammonia vapour. [Abstract 1688 (1925).] A. W. L.

2539. *Specific Heats of Binary Mixtures.* **J. W. Williams** and **F. Daniels.** (Am. Chem. Soc., J. 47. pp. 1490–1503, June, 1925.)—Having already investigated the specific heats of certain organic liquids [see Abstract 2801 (1924)], the authors have now turned their attention to the specific heats of binary liquid mixtures at various concentrations from 20° to 60°. The systems studied are benzene-toluene, chloroform-carbon tetrachloride, chlorobenzene-bromobenzene, benzene-carbon tetrachloride and chloroform-acetone. Of these the first four may be considered to be nearly ideal solutions. The partial molar heat capacities of the constituents at various temperatures have been calculated for each of the systems studied. The specific heats of pure acetone, chlorobenzene and bromobenzene have been determined and the results recorded as graphs and as empirical equations. The authors discuss each of the systems, and attempt to explain the nature of the deviations between the molar heat capacities of the pure liquids and the partial molar heat capacities in solution. It is evident that the changes taking place in solution are intricate, and that dissociation phenomena are probably more important than has been recognised. W. C. S. P.

2540. *The Total Heat of Superheated Steam at High Pressures. A New Method of Measurement, including the Latent Heat.* **H. L. Callendar.** (World Power, 3. pp. 302–312, June, 1925.)—Three types of apparatus were employed: (1) A differential throttling calorimeter for observing the drop of temperature with pressure at constant H, and deducing the variation of the total heat with pressure at constant temperature; (2) a differential electric calorimeter for observing the rise of temperature produced by a measured supply of electric energy, and deducing the value of the specific heat at constant pressure; (3) a jacketed condenser for measuring the total heat given up in the condensation of a measured steam-flow by a measured flow of cooling water, and deducing the absolute value of the total heat at any pressure or superheat. In each case the steady flow method of calorimetry was adopted on account of its many advantages. The primary object of the third method was the verification of the tables near saturation. The results confirm the value 639·3 calories for H at 100° C. given in the steam tables. For the complete discussion of the results obtained the original paper should be consulted. [See also Abstract 2292 (1924).] W. C. S. P.

2541. *Condensation Nuclei produced by the Illumination of Air-Halogen Mixtures.* **I. C. Jones.** (Phys. Soc., Proc. 37. pp. 287–296, Aug., 1925.)—It is shown that the production of condensation nuclei, previously known to take place on illumination of air saturated with iodine vapour, also takes place under similar conditions with bromine and chlorine; the usual tests indicate that the nuclei in all three cases are similar. The effect occurs in two distinct stages: (1) A surface action dependent on the presence on the surface of traces of some oxidisable substance;

(2) formation of nuclei in the " activated " vapour by illumination. A parallel is shown to exist between the conditions under which nuclei are found and those under which an induction period is observed in the hydrogen-chlorine reaction. AUTHOR.

2542. *The Properties of Active Hydrogen.* **H. Senftleben.** (Zeits. f. Physik, 33. 10–11. pp. 871–878, 1925.)—In a previous paper by the same author on the effects of radiation on gaseous mixtures [Abstract 2323 (1925)] it was shown that a mixture of hydrogen and mercury-vapour, if excited by the resonance line ($\lambda = 2537$ Å.U.), gave a definite measurable effect. This was seen as an alteration of the thermal conductivity of the gases, and it was attributed to dissociation of the hydrogen. It is shown that the two kinds of atomic hydrogen, such as that which is obtained above and that obtained by discharge by Wood and Bonhoeffer and named active hydrogen, have the same thermal effect. The catalysts in both cases are the same, and the estimation of the life duration of both kinds leads to the same result, so that the two must be considered as identical. S. G. B.

2543. *An Investigation of the Control Conditions under which Newton's Law is Valid for the Emission of Heat from Electrically-heated Wires.* **Sybil Marshall** and **J. O. C. Vick.** (Phys. Soc., Proc. 37. pp. 312–321 ; Disc., 321–323, Aug., 1925.)—The following paper deals with the variation with temperature excess of the controlled heat loss from an electrically-heated wire. The wire, whose temperature was measured by means of a Callendar-Griffiths bridge, was surrounded by air at a known pressure enclosed in a glass tube, the latter being immersed in a constant temperature bath. The rate of heat loss, therefore, could be calculated from a knowledge of the current used and the resistance per unit length of the wire. Total heat loss/temperature excess curves were plotted, these tending to become straight lines as the convection was reduced. AUTHORS.

2544. *The Statical Partial Function in the Radiation and Atomic Heat Theory.* **E. Császár.** (Zeits. f. Physik, 32. 11–12. pp. 872–880, 1925.)—A reply to the criticism by Schrödinger [Abstract 2544 (1924)] of a previous work by the same author. The present paper shows that the basis of the author's work is sound and that the deductions therefrom are in agreement with practice and experimental results. Finally, the formula deduced is shown to lead to Wien's radiation law and Rayleigh's radiation formula by simple application of special cases. The partial function is shown to be easy to use and the Schrödinger method to lead to empirical formulæ. The paper is mathematical throughout. S. G. B.

2545. *Equilibrium between Radiation and Matter.* **W. Westphal.** (Zeits. f. Physik, 33. 7. pp. 557–562, 1925.)—Criticises J. K. Syrkin's paper on the Planck radiation law, in which on certain assumptions the equilibrium between radiation and matter is treated as analogous to evaporation [see Abstract 1695 (1925)]. There is a double error in these assumptions, and as the two errors cancel one another, Syrkin's final result agrees with Planck's law. The energy conditions in the two cases are in reality quite different, and it is impossible to make use of this analogy. It is possible, however, to make use of the second law of thermo-

dynamics in considering both the above cases of equilibrium, if one assumes the general law of entropy for a system consisting of a number of absorbing molecules and of free and absorbed radiation, and seeks the state of maximum entropy. The calculation cannot be expected to give any new result, but is carried through for the case of an ideal gas, on the assumption that the molecules have a single natural frequency and the ordinary laws are obtained. H. N. A.

2546. *Planck's Law, Light Quanta and Coherence.* **A. Landé.** (Zeits. f. Physik, 33. 8. pp. 571–578, 1925.)—The deduction of Planck's radiation law from the light quantum theory can be done only, according to Bose [Abstract 2812 (1924)], with the aid of a theory of probability in which the light quanta are considered as having a structure in which they are statically dependent upon each other in an unexplained manner and also upon their assigned polarisation. This law of probability can also be derived without static dependence on light quanta if an analogy to classical wave interference is considered. This interference theory is applied to Einstein's theory of gaseous degeneration. The quantum bundle is also shown as the basis for the exchange of energy between radiation and matter. S. G. B.

2547. *Two Demonstrations from Bose-Einstein Statistics.* **A. Smekal.** (Zeits. f. Physik, 33. 8. pp. 613–622, 1925.)—The paper consists of the proof of two deductions from the Bose-Einstein theories [Abstracts 2812 (1924) and 159 (1925)]. In the first the Bose-Einstein statements are shown to be the simplest special case of a statistical method, in which, by complete regard of the modifications imposed by classical thermodynamic laws, an aspect is presented of the fundamental exchange effects between molecules without in any way making use of the agglomeration hypothesis. In the second problem it is shown that on the ground of the classical correspondence characteristics of radiation and a material system an indication is given of the intrinsic value of the Bohr frequency conditions, which can be regarded as the basis of Bose's deduction of Planck's radiation law by means of the orthodox light quantum theory. S. G. B.

2548. *Infra-red Radiation and Combustion Rate of Gases.* **W. T. David.** (Roy. Soc., Proc. 108. pp. 617–627, Aug. 1, 1925.)—The combustion rate after ignition in a closed vessel was inferred from the rate of rise of pressure, determined by an optical indicator, for mixtures of hydrogen, carbon-monoxide or methane with air. In the first type of experiment pressure-time curves taken during the explosion of identical mixtures were compared, firstly when radiation from an electrically-heated nichrome coil (at 700° C.) was passed through a fluorite or quartz window into the combustion chamber, and secondly when no radiation was passed in. In the second type of experiment no radiation was passed into the chamber, but the radiation density of those types of radiation emitted by the burning gases during the explosion period was varied either by polishing the silver-plated interior or by coating it with a thin layer of dull black paint. An increased rate of combustion as indicated by the pressure-time curves was found in all cases when the superimposed radiation (first type of experiment) or the increased radiation (second type) was of a kind which could be absorbed by the combustible gases. The experiments are thought to prove conclusively that the

absorption of radiation by the reacting gases promotes combustion, and attention is also directed to the influence upon it of rotational and vibrational intra-molecular energy of the reacting molecules. Six pairs of typical pressure-time graphs are given. W. H. Ge.

2549. *The Isothermals of some Gases between* 400° *C. and* — 183° *C.* **L. Holborn** and **J. Otto.** (Zeits. f. Physik, 33. 1–2. pp. 1–11, 1925. From the Reichsanstalt.)—The authors give the results of measurements on hydrogen and neon together with a summary of previously obtained values of pv for helium, nitrogen, air, argon and oxygen [see Abstract 1146 (1925)]. The paper contains nine pages of observations. The apparatus previously described was used. As the results for neon previously obtained were arrived at from a mixture of neon and helium it was deemed advisable to make the present observations on pure neon. The tables also contain the calculated values of the coefficients of the equation $pv = A + bp + cp^2 + Dp^4 + Ep^6$ and $[d(pv)/dp]_{p=0} . 10^5 = B . 10^5 = a + bT + c/T + e/T^3$, where $T = (273 + t)/100$, and also the corrections of the gas thermometers to the thermodynamic scale for a pressure of 1 metre of mercury. T. B.

2550. *On the van der Waals Equation of State.* **J. J. van Laar.** (Zeits. phys. Chem. 116. pp. 119–122, May, 1925.)—A criticism of the two papers by J. Berger on the van der Waals equation [see Abstracts 167 and 2127 (1925)]. The author expresses surprise that in these papers the quantities "a" and "b" should be regarded as constants. He points out that van der Waals abandoned such ideas more than forty years ago and that he showed irrefutably that a and b are functions of both v and T. He refers to his own work on the subject, and points out that the property of additivity is possessed by $\sqrt{a}$ instead of a. W. C. S. P.

2551. *The Limits of Detonation in Explosive Gas Mixtures.* **R. Wendlandt.** (Zeits. phys. Chem. 116. pp. 227–260, June 15, 1925.)—This paper is based on an experimental investigation of the limits of detonation. (See R. Wendlandt, *ibid.*, 110. p. 637, 1924.) It is divided into three sections; the first contains a preliminary description of the phenomena, the second develops the necessary mathematical equations, and the third contains the evaluation of the experimental results. The Liemann-Hugoniot equation is obtained and the important deductions made by Jouguet (who used Mallard and le Chatelier's suggestion that in a detonation wave the gaseous mixture is heated to ignition temperature by adiabatic compression) are discussed. Reference is also made to the work of Dixon, Coward, and Becker. The phenomena arising at the limits of detonation are found to depend in a great measure on the relation between the velocity of the wave and the time required for chemical change to take place. The case of hydrogen-air mixtures, CO-air mixtures, CO-oxygen mixtures and marsh-gas mixtures are considered in detail. From a knowledge of the limits of detonation we can derive useful information as to the chance of a detonation occurring in a given mixture. We may also obtain information on reaction velocity at high temperatures. T. B.

SOUND.

2552. *Partial Tones of Struck String. I. Experimental Investigation of the Fundamental.* **W. H. George.** (Phil. Mag. 50. pp. 491–499, Aug., 1925.)—By the harmonic analysis of photographically-obtained vibration curves of the struck string it is found that (1) the amplitude of the fundamental is greatest when the string is struck near one of the bridges; (2) the position of this maximum point is nearer the bridge the greater the relative mass of the hammer; (3) there are other maxima and minima which become fewer and less pronounced as the relative mass of the hammer is reduced until for the mass ratio $m/M = 1/2{\cdot}53$ there is only one minimum and maximum for the whole length of the string; (4) the maxima are greater and the minima less the nearer they are to a bridge. The paper includes eight photographic reproductions of vibration curves and five diagrams with graphs. [See Abstracts 2560 and 2561 (1924).] E. H. B.

2553. *Interfering Effect of Tones and Noise upon Speech Reception.* **V. O. Knudsen.** (Phys. Rev. 26. pp. 133–138, July, 1925.)—The interfering effect upon speech of tones and noise was measured by determining the percentage of vowel, consonant and word articulations correctly heard by an observer who listened in the presence of a tone or noise to meaningless monosyllables spoken at a distance of 2 metres. The interfering tones varied in pitch by octaves from C_2 (128 d.v.) to C_7 (4096 d.v.) and in loudness from slightly above minimal audibility to near the painful limit. The interfering effect increases with increasing loudness of tone or noise at an accelerated rate; for tones with a loudness less than the loudness of the speech the effect is almost independent of the pitch, but as the interfering tone becomes louder, the tones of lower pitch produce a relatively greater and greater interference. These results are consistent with the auditory masking data of Fletcher, Wegel and Lane. A noise produces twice the interfering effect of a tone of the same loudness. These results indicate that for good hearing in an auditorium the speech energy should be from 1000 to 10,000 times the energy of any interfering noises, and that sound-absorbent materials for the reduction of noises in auditoriums should absorb equally tones of all pitches below C_7. Some experiments with rather deaf persons will be reported elsewhere.

Author.

2554. *Secondary Waves in Air in Pipes.* **T. Vautier.** (Comptes Rendus, 180. pp. 1919–1922, June 22, 1925.)—The effect of sudden constrictions and enlargements of the pipe on the echoes and secondary disturbances from an explosion wave are found. With a slight enlargement of the pipe for a short distance, the resultant wave agrees with the theory that it is due to the superposition of two secondary waves of contrary sign and slightly displaced. A slight reduction of the cross-section gives another double wave, and the time elements of these waves both agree well with the length of the obstructions producing them. The periodic vibrations induced by openings in the pipe are also noticed.

A. Wh.

ELECTRICITY AND MAGNETISM.

THEORY, ELECTROSTATICS, AND ATMOSPHERIC ELECTRICITY.

2555. *Remark on the Reeves Experiment.* **S. Ray.** (Zeits. f. Physik, 33. 8. pp. 643-645, 1925.)—The author has previously shown that a magnet pole which moves in a circular orbit is equivalent to a dielectric double layer, with a positive charge on one side and a negative on the other [Abstract 603 (1920)]. He considers that the velocity of the two poles of the small magnet to which the magnetism of the earth can be ascribed may be different, so that the effect of the earth's rotation is to produce a resultant electrical dipole. This would make the electric field of the earth parallel to the magnetic field instead of being radial. This agrees with the observation of Rudge, who found a positive charge on the earth's surface at Bloemfontein, while in the northern hemisphere it is negative. Bauer has called attention to large variations of the surface density of the earth's assumed charge. The suggestion would help to explain the aurora borealis as a movement of ions, electrons or α-particles from the sun along the electrostatic lines of force, the direction of which agrees with that of the magnetic lines. The experiment of Reeves, which has been repeated in Spitzbergen, Cameroon, Arizona, etc., serves as a proof of the existence of the horizontal component of the electrical dipole field of the earth. H. N. A.

2556. *Motion of Electricity in Metals.* **H. A. Lorentz.** (Inst. of Metals, J. 33. pp. 257-278, 1925. Engineering, 119. pp. 625–626, May 22, 1925.)—After interesting introductory remarks relating to earlier theories and recent rapid progress, the lecturer showed that the electron theory of to-day leads to an explanation of Ohm's law. At all events, it would be more difficult *not* to find this law. Then he showed that the foregoing general considerations also suffice to explain Tolman and Stewart's beautiful experiments on the currents produced by the acceleration or retardation of a conductor, by which it was proved directly that the current consists in a motion of negative electrons. In applying Maxwell's dynamical theory to Tolman and Stewart's experiment the kinetic energy of moving bodies carrying electric currents may be conceived as made up of three parts: Maxwell's T_m is the kinetic energy of the matter of the conductors, T_e is due to the electric currents alone, T_{me} arises from combination of the motion of the conductors with that relatively to them of the electricity which they contain. Maxwell's main interest was centred on the question whether T_{me} really exists, and he thoroughly discussed the effects to be anticipated, and tried to observe some. His instruments were not sensitive enough, but the currents observed by Tolman and Stewart originate in T_{me}. When the conductor is at rest the mass of the electrons will make itself felt. The lecturer next discussed Drude's theory of electric conduction, indicating some of its achievements and some of the difficulties which its acceptance would involve. Finally, the lecturer turned to the beautiful discovery made by K. Onnes in his

cryogenic laboratory : several metals completely, or almost completely, lose their resistance when by means of liquid helium they are cooled down below a certain temperature, 4·2° K. in the case of mercury, 3° K. for tin, and 7·3° K. for lead. Below this point of discontinuity electric currents can persist in the metal for hours and days, and it seems that practically the body may in many cases be regarded as a perfect conductor without resistance. The existence of the currents can be shown either by their action on a small magnet or by the ponderomotive forces exerted on the body by an external magnetic field. The final conclusion arrived at was that in the supra-conductive metal the electrons are not *wholly* free. It seems as if definite paths were prescribed along which they can move without encountering resistance, but which they cannot leave sideways. G. W. DE T.

2557. *On Electric Charges carried by Individual Microscopic Particles.* **T. Sexl.** (Phys. Rev. 26. pp. 92–96, July, 1925.)—In the experiments of Derieux with mercury droplets, observations of the same droplet were made at different pressures. The size of one droplet, which apparently was constant in mass and not disturbed by air currents, is computed and a result obtained different from that obtained by Millikan's method of computation. The charges computed by using the size so determined are not multiples of a unit charge. This confirms Ehrenhaft's conclusion that other electric charges are stable on microscopic and sub-microscopic metallic particles than those stable on particles of dielectrics. AUTHOR.

2558. *Reply to T. Sexl's Criticism of R. A. Millikan's Method of Computation of the Elementary Electrical Charge on Mercury Droplets.* **J. B. Derieux.** (Phys. Rev. 26. pp. 97–98, July, 1925.)—It is shown that Sexl's test method [see preceding Abstract] is in error because it is based upon the assumption that the droplets remain of the same size throughout the observations. Data are given which prove that because of evaporation such is not the case. Errors also are shown in his computations which, when corrected, give results approximating those by the Millikan method, with the difference in favour of the Millikan method. AUTHOR.

2559. *The Nature of the Evidence for the Divisibility of the Electron.* **R. A. Millikan.** (Phys. Rev. 26. pp. 99–104, July, 1925.)—The purpose of this note is to remove misconceptions due to erroneous statements regarding the determination of the elementary electronic charge by the oil-drop method. It is emphasised that the existence of an elemental charge is directly proved by the multiple relationship shown to exist between successive charges on each test particle ; that the unitary character of electricity is not presupposed even in determining the absolute value ; and that the method used by Sexl [see Abstract 2557 (1925)] in determining the radius of the droplet is not essentially new. Recent photoelectric work of Hake and of Wasser is discussed briefly. AUTHOR.

2560. *On Elster and Geitel's Theory of the Electrification of Raindrops.* **T. E. W. Schumann.** (Phys. Rev. 26. pp. 105-110, July, 1925.)—The following experiments were made to test Elster and Geitel's theory of the electrification of raindrops. Large drops (A drops) falling between

the horizontal parallel plates of a charged condenser were sprayed from below with a fine stream of small drops (B drops), and the charge on the A drops was found to be of the same sign as that of the upper plate and to be proportional to the field strength. From the charge per A drop and the probable number of collisions with B drops the charge per collision was computed and found to be zero for B drops of radius less than 0·18 mm. and then to increase rapidly with the radius to 0·4 mm. Photographs taken with a motion-picture camera show that the B drop first coalesces with the A drop, and then, if its momentum is sufficient, a protuberance is produced on the upper surface of the A drop which breaks up into a number of small droplets, which carry off with them not only part of the A drop, but also some charge. Very small B drops probably merely coalesce with A drops. In the case of falling rain, cloud droplets are too small to have a charging effect, and the effect of larger drops overtaking smaller ones is to weaken the existing field. Hence it is doubtful whether this phenomenon alone can explain the observed charges on raindrops, and it certainly does not explain such high potential differences as occur in lightning discharges. AUTHOR.

2561. *On the Quantitative Theory of Electrostatic Systems.* **A. W. Simon.** (Phys. Rev. 26. pp. 111–117, July, 1925.)—It is shown that if any system of insulated conductors is carried through a periodic cycle of electrostatic operations, the potential of any conductor of the system after n, such cycles can be expressed in the form of a recurrent sequence. A general formula is then deduced for the potential of any conductor of the system after n cycles. The application of the formula to the case of electrostatic generators, electrostatic alternators, and electrostatic voltage multipliers is discussed. Methods of solution (1) for the case of a symmetrical alternator consisting of m inductors and m carriers so constructed that each carrier as it comes in front of an inductor is connected to the next following inductor, (2) for the Wimshurst alternator of four inductors, and (3) for a new type of symmetrical alternator derived from the Wimshurst alternator by doubling the number of inductors. Finally, it is shown how a simple electrostatic system can be made to function as a generator, alternator, or a voltage multiplier merely by a change of connections. AUTHOR.

2562. *The Electrostatic Capacity of Two Spheres when Touching one Another.* **A. Russell.** (Phys. Soc., Proc. 37. pp. 282–285; Disc., 285–286, Aug., 1925.)—Formulæ are given to enable the electrostatic capacity of two unequal spheres in contact to be computed more easily. It is shown that the natural logarithm of any number n can always be expressed as the sum of the capacities of a limited number of pairs of spheres in contact, the number of pairs never being greater than $n/2$. For instance, log 7 is the sum of the capacities of the pairs of spheres whose radii are (1, $\frac{1}{6}$), ($\frac{1}{2}$, $\frac{1}{5}$), and ($\frac{1}{3}$, $\frac{1}{4}$) respectively. Several similar relations are pointed out. An exact formula is given for the capacity of the pair of spheres, whose radii are a and b respectively. The formulæ given are a help when computing the capacity coefficients of unequal spheres when very close together. AUTHOR.

2563. *Electrification of Gases by Surface Combustion.* **J. Dickinson.** (Phil. Mag. 50. pp. 225–241, July, 1925.)—The experiments described

were suggested as a possible means of explaining certain phenomena of boilers and boiler furnaces now known to be associated with surface combustion—*e.g.* the secondary effects accelerating corrosion and the exceedingly high local temperatures reached. The main object in view was the measurement of the rate of growth of charge gained both by a chamber in which surface combustion is taking place and by an electrode surrounding the products of combustion after they have passed from this chamber. A measure of the ionisation accompanying gaseous combustion of any kind is thus obtained. For experimental details and results the original paper should be consulted. A. B. W.

2564. *Further Investigations on Contact Electrification for finely-divided Bodies, particularly Snow.* **A. Stäger.** (Ann. d. Physik, 77. 3. pp. 225–240, Aug., 1925.)—Experiments were continued at a high level near Berne on the electric charge per unit mass for rime, and for snow during light and heavy falls under different conditions of wind. Values are given, and the magnitude was found to increase with the wind speed and to differ if a change occurred in the kind of snow falling or in its amount. The small light particles carried a negative charge and the larger heavy particles a positive charge. The potential gradient over snow was mostly negative and seldom positive. Tests were also made on electrification produced by solid CO_2 and by sand. The results obtained were applied to explain the illumination often seen with a dust cloud and the electrification arising during falls of snow, hail and soft hail, and also partly that for the storms produced by heat and whirlwinds. Where precipitation also occurs in the liquid form other sources of electrification exist. [See also Abstract 1170 (1925).] R. S. R.

2565. *The Earth's Electric Field and its Vertical Potential Gradient.* **S. Ray.** (Zeits. f. Physik, 33. 1–2. pp. 48–52, 1925.)—The average values of the potential gradient of the earth's electric field given by Schweidler and Kohlrausch indicate an exponential decrease with height. From theoretical considerations formulæ are developed giving fair agreement with the curve found experimentally and taking account of changes of potential gradient in relation to changes of pressure and of humidity. Further, by considering separately the constituents of air and such impurities as dust, smoke and water particles, still better agreement is obtained. R. S. R.

DISCHARGE AND OSCILLATIONS.

2566. *Flame Tension of the Glow Discharge.* **G. Valle.** (Phys. Zeits. 26. pp. 495–497, Aug. 25, 1925.)—This paper refers particularly to the work of Geffcken on flame tension and the stability of the intermittent glow discharge [Abstract 1703 (1925)]. Attention is directed to previous work by the author [Abstracts 1250 (1912) and 139 (1920)] on the glow discharge which on certain points is not in agreement with Geffcken's results. A. W.

2567. *Sparking Potentials and Glow Discharge.* **W. Dällenbach.** (Phys. Zeits. 26. pp. 483–495, Aug. 25, 1925.)—A comprehensive theoretical treatment of the question of sparking potentials and of the kathode fall of potential in the glow discharge in other than the rare gases. Among

numerous conclusions arrived at are the following : The kathode fall in a "free" glow discharge, its distribution $\phi(x/s)$ across the breath s of the ionisation zone, and the product ps (where p is the gas-pressure) depend, for a given gas and a given kathode material, only on the ratio of the current density i to the square of the pressure. The kathode fall of potential of an " impeded " glow discharge and its distribution across the electrode distance s depends, for a given gas and a given kathode material, apart from the product ps, likewise only on the ratio i/p^2. This includes Paschen's law as a special case. A further paper will be published later. A. W.

2568. *Low-voltage Arcs in Rubidium and Cæsium Vapours.* **F. H. Newman.** (Phil. Mag. 50. pp. 463–470, Aug., 1925.)—In a previous paper on low-voltage arcs in sodium and potassium vapours [Abstract 1941 (1925)] the author showed that the potentials required to strike and maintain arcs in these vapours depend primarily upon the vapour density and the temperature of the incandescent kathode, these potentials decreasing as the vapour density and the supply of electrons increase. Experiments with rubidium and cæsium vapours have given similar results. In cases where cumulative ionisation is predominant, low-voltage arcs may be maintained in vapours at voltages considerably lower than their ionisation potentials. Atoms in the metastable condition are then ionised by direct impact, and the negative space charge around the incandescent filament is neutralised. As a result the supply of electrons is no longer entirely decided by the temperature of the filament, but there is in the immediate neighbourhood of the kathode an accelerating field which increases the electron current to its saturation value. A. W.

2569. *The Glow Discharge in rapidly alternating Fields.* **F. Kirchner.** (Ann. d. Physik, 77. 3. pp. 287–301, Aug., 1925.)—The glow discharge, it is found, can, with rapid undamped oscillations, be generated and maintained at very low tensions and low pressures. It is believed that these appearances can be traced to the increased ionising action of electrons which swing to and fro in the alternating field. The dependence is investigated of the ignition tension and flame tension on the pressure for different frequencies and different electrode distances in air, oxygen, hydrogen and neon. The free path of the electrons for ionising can be calculated from the measurements obtained. Qualitative observations are also made on the optical variations of the glow discharge with transition to low tensions. The apparatus employed is described with the aid of diagrams, and the results are shown in both graphical and tabular form. A. E. G.

2570. *Electric Discharge Mechanism in Water containing Fluid Insulators.* **A. Gyemant.** (Zeits. f. Physik, 33. 10–11. pp. 789–800, 1925.)—A theory of electric discharges or breakdown of damp fluid insulators is deduced. The assumption is made that, in emulsions of conducting particles in liquid dielectrics where electrical breakdown is created, the spherical particles become drawn out in one direction by the high electrical field into rotation ellipsoids, which at a definite field strength form a conducting canal through which the breakdown or discharge is conducted. The above statement was investigated mathematically and verified by comparison of figures obtained by R. Friese for the connection between

breakdown potential and water content of damp transformer oils. The theory is to be extended to the case of homogeneous fluid dielectrics.
S. G. B.

2571. *The Schottky-Effect in Low-frequency Circuits.* **J. B. Johnson.** (Phys. Rev. 26. pp. 71–85, July, 1925.)—(1) In the absence of space charge. This effect, discovered by Schottky, which depends on the probability fluctuations of electron emission from a filament, has been measured over a considerable range of conditions in resonant circuits of which the natural frequency was varied from 8 to nearly 6000 p.p.s. The effect is much larger in the lower range of frequencies than the theory predicts. With a tungsten filament the ratio of observed to theoretical effect e'/e is about 0·7 for frequencies above 200, but increases rapidly to 50 at 10 cycles per sec. With an oxide-coated filament the ratio increases from 1 at 5000 cycles to 10 at 100 cycles. This is interpreted to mean that the emission of electrons is not strictly chaotic, but is influenced by irregular temporal changes in the kathode emissivity. In a high-frequency circuit these changes become imperceptible, and the emission is effectively random. (2) When current is limited by space charge the Schottky-effect decreases because of the interaction of the electrons, and other disturbances may act upon the space charge so as to completely mask the remanent Schottky-effect. The magnitude of the disturbances in amplifying vacuum tubes can therefore not be predicted from measurements on the true Schottky-effect.
AUTHOR.

2572. *Effect of Gas Absorption on the Photoelectric Emission and the Electric Conductivity of Platinum.* **K. Herrmann.** (Ann. d. Physik, 77. 5. pp. 503–536, 1925.)—A research is described which shows that the effect of gas absorption by platinum foil is to reduce the photoelectric effect and to increase the electric resistance. In oxygen the photoelectric effect is only slightly influenced, while the resistance increases. Further incandescence of the foil *in vacuo* reduces the photoelectric effect and raises the resistance. An explanation of these effects is given. The effect of hydrogen is to increase considerably the photoelectric effect; the resistance at the same time decreases considerably. These effects are explained as being due to the increase in the number of free electrons in the platinum foil due to the occlusion of the hydrogen. A. W.

2573. *New Method of Production of Slow Kathode Rays.* **G. Reboul.** (Comptes Rendus, 180. pp. 1735–1737, June 8, 1925.)—At the same time that radiations of short wave-length are produced by cells of high electric resistance carrying current, there are projected into the surrounding medium positively or negatively charged particles, according to the sense of the voltage producing the current in the cell. In the case of the emission of negative charges the author shows, working at reduced pressures, that they are slow kathode rays. The velocity of these rays depends essentially on the voltage applied to the resistance-cell. For voltages of 880 volts the velocity corresponds to 200 volts, whilst for 450 volts the velocity corresponds to only about 60 volts. [See Abstract 1640 (1925).]
A. B. W.

2574. *Effect of Kathode Rays on Photoelectric Emission.* **H. Dember.** (Zeits. f. Physik, 33. 7. pp. 529–532, 1925.)—Arrangements were made

permitting the photoelectric emission from an aluminium plate to be measured (i) when illuminated by the light from a mercury lamp in quartz, (ii) when subject to the primary electron stream from an incandescent filament, and (iii) when both (i) and (ii) were used. The auxiliary photoelectric effect, L = (iii) − (i) − (ii), which is at first only 0·3 times the pure photoelectric effect (i), reaches a value 148 times as large and has a value of $1 \cdot 3 \times 10^{-6}$ amp. with an aluminium plate 24 mm. diameter. With a constant primary electron stream the auxiliary effect increases up to a certain point with increased intensity of the incident light from the mercury lamp; beyond this point the increase is slight, the curve being similar to an ordinary saturation curve. The effect of interposing glass screens of various colours in the path of the incident light was also investigated. Least auxiliary effect was obtained when a red screen was used. A. W.

2575. *Saha's Ionisation Formula and the Theoretical Value of the Photoelectric Absorption Coefficient.* **E. A. Milne.** (Phil. Mag. 50. pp. 547–550, Sept., 1925.)—It is shown that Saha's formula for high-temperature ionisation requires a factor (the partition function for the ionised atom) as well as the factor relating to the stationary states of the neutral atom introduced by Fowler [see Abstracts 218 (1921) and 1484 (1923)]. The formula for the photoelectric absorption coefficient requires similarly a factor for the weight of the lowest state of the ionised atom, as well as the factor for the weight of the neutral atom given by Kramers, Becker and the author. In all cases a ratio of weights is necessarily involved. A. W.

2576. *The Relative Ionisation in Different Gases for Slow-moving Electrons.* **W. P. Jesse.** (Phys. Rev. 26. pp. 208–220, Aug., 1925.)—A uniform beam of electrons was obtained by allowing thermions from a tungsten filament to fall through a given potential difference between the filament and a perforated plate and to pass through the plate into a short region devoid of strong electric fields. There, due to the energy acquired, they ionised the gas present, the positive ions being caught on a concentric ring element and the electrons themselves on a plate opposite the perforated plate. With the pressure low enough to prevent secondary effects the ionisation was determined for electron energies ranging from 20 to 300 volts. With increasing electron energies the ionisation in each gas was found to reach maximum at the following voltages: for He 140, Ne about 220, A 100, CO 120 and N_2 100 volts. For 200 volts the relative ionisations at 1 mm. pressure, with reference to that in Ne taken as 1·0, are: H_2 0·91, He 0·48, CH_4 3·5, N_2 3·2, CO 3·45, A 4·1. The results are in good agreement with those of Hughes and Klein [Abstract 1496 (1924)], except that the value for argon is 0·7 higher. A second maximum was observed in each case at 350 to 400 volts, which was probably due to secondary rays, but is not completely understood. Author.

2577. *Ionisation in Flames.* **E. Marx.** (Ann. d. Physik, 76. 7. pp. 737–784, May, 1925.)—A comprehensive theoretical and experimental investigation of the phenomena of ionisation in flames. The first part deals with the relation between mobility and displacement, and the second part with the dependence of the number of charges on the atomic

weight, the recombination coefficient, and the concentration. Results are given for the alkali metals. The original paper should be consulted as a brief abstract cannot be given. A. W.

2578. *On the Kinetic Theory of the Thermionic Effect.* **N. V. Raschevsky.** (Phys. Rev. 26. pp. 241–246, Aug., 1925.)—Making different assumptions as to the behaviour of electrons inside a solid body, statistical deductions for the thermionic currents in the corresponding cases are made. All the formulæ obtained are of the type $i = AT^a e^{-b/T}$ and differ only in the values of A and a. The following cases are investigated: (1) The electrons inside a body are assumed to behave like a perfect gas. In this case a comes out 1/2. (2) The electrons are assumed to be arranged in a space-lattice with the same dynamical properties as the ordinary crystal-lattices. For this case $a = -1$. (3a) All electrons are assumed to be moving on quantised orbits with the same quantum number and energy. For this case $a = 2$. The case (3b), in which the electrons inside the metal are assumed to be divided into S groups, each group i moving in an orbit with the quantum number i, is more complicated and will be discussed in a separate paper. The experimental results are at present not accurate enough to decide between these values of a. AUTHOR.

2579. *The Thermionic Effect from the Standpoint of the Phase Rule.* **N. v. Raschevsky.** (Zeits. f. Physik, 33. 8. pp. 606–612, 1925.)—The emission of electrons from glowing bodies cannot be regarded simply as a vaporisation of electrons; the influence of positive ions and the vaporisation of neutral molecules must also be considered. By the application of the phase rule, considering the system composed of two components, electrons and positive ions, in two phases, solid and gaseous, the thermodynamical potential for the state of equilibrium is deduced. The relation of this potential to the electronic concentration gives a thermodynamical expression for the thermionic electron current, which embraces the Richardson formula $i = AT^c e^{-b/T}$ as a special case, and shows that the constant A in this relationship is not a universal constant. A relationship between the electronic emission, vapour-pressure and specific heat of a body is deduced. B. W. C.

2580. *Recent Researches in Positive Rays.* **W. Wien.** (Phys. Soc., Proc. 37. pp. 324–334, Aug., 1925. Guthrie Lecture.)—The experiments here described are those which have been carried out in Germany. The first object of the experiments was the investigation of the conversion of charged particles into uncharged, and *vice versa*, which takes place in the positive rays owing to collisions with gas molecules. The first apparatus for determining the free paths and the relative numbers of charged and uncharged particles is described with the aid of a diagram. In this work ordinary canal rays composed of particles of mixed velocities and comprising atoms and molecules of different chemical elements are used. Rüchardt's apparatus, which enabled him to study homogeneous pencils of particles, is also described. A graph given shows that the reciprocal of the mean free path, L_1, when plotted against the pressure, gives a straight line, but the latter does not pass through the origin as required by theory, though the mean free path must be infinite for zero pressure. But Rüchardt was able to show that this discrepancy arises from a residue of vapour in the discharge tube, which cannot be removed even by the

most rapid Gaede pump. A graph shows how L_2, the mean free path for uncharged particles, depends on the velocity. L_2 decreases as the potential is raised. L_1, on the other hand, increases as the potential is raised. Rüchardt's measurements are fairly accurate. The mean free path of a hydrogen atom moving with the velocity of the positive rays is known to an accuracy of a few per cent. Besides the mean free paths for charged and uncharged atoms, other mean free paths connected with the light emission of the positive rays must be considered. The luminosity of these high-velocity atoms also arises from collisions with molecules of the gas in the discharge tube. There are two kinds of collisions: (1) Those which are responsible for the emission of light, and (2) those which destroy the emission of light from an excited atom. The latter are here termed "perturbations." Corresponding to these there are two kinds of mean path, and there is a third kind corresponding to the duration of luminosity in a pure vacuum. The duration of luminosity is determined by employing an apparatus in which the canal rays passed through a short, narrow slit into a region of high vacuum. For the strongest lines of H, O, N, He, and Hg, it is found that the intensity of light emission decreases according to an exponential law with distance measured along the path of the rays, and from the exponential constant the mean luminous path can be calculated. Using a modification of the apparatus designed for the measurement of the duration of the luminosity, it has been possible to discriminate between the spectral lines from charged and uncharged particles. In close connection with the problem of luminosity is the paradoxical fact that the Doppler displacement reaches a limit with increase of the voltage accelerating the canal rays. Krefft has raised the voltage of a discharge tube filled with hydrogen to 70,000 volts, but found no limit to the Doppler shift. He found, however, that the absolute value of the shift is smaller than that which would be expected from theory. An interesting method for the observation of the Doppler effect has been worked out by Rau. Rau obtained evidence of band-spectra emitted by positively charged nitrogen molecules, and the author confirmed this by the method of deflection. Rau also found, with very long exposures, that the second spectrum of hydrogen shows very faint Doppler lines. The electromagnetic analysis of positive rays by Döpel has given some interesting new results. A graph shows the parabolas obtained by means of simultaneous electric and magnetic fields. Besides the well-known parabolas of H, H_2, H_3, He, Ne, with positive charges, negatively charged hydrogen molecules and helium atoms are found. In almost all the parabolas there are two maxima of intensity at two different velocities; the existence of H_2, H_4, but not of H_6, may be assumed, since the parabola of H_3 does not show a second maximum. A. E. G.

2581. *Acceleration of Canal Rays.* **F. Hoffmann.** (Ann. d. Physik, 77. 3. pp. 302–312, Aug., 1925.)—The general method and experimental arrangements are given in detail and illustrated diagrammatically for obtaining homogeneous canal rays. The results are given in both tabular and graphical forms. It is shown that with the arrangement described no scintillation of the canal rays could be seen. A. E. G.

2582. *Generation of Polyphase Oscillations by Means of Electron Tubes.* **R. Mesny.** (Inst. Radio Eng., Proc. 13. pp. 471–476, Aug., 1925. Onde Élec. 4. pp. 232–239, June, 1925.)—The general principle on which these

experiments are based is as follows: If a connection having a geometrical and electrical symmetry of the order n is obtained by n identical triodes, the system constituted in this way should form under favourable conditions a unit of polyphase oscillations of the order n. This proposition is obvious, but it remains to be established *à priori* whether the operation of such a system is stable. The slightest difference between two homologous elements, for instance, might interrupt the polyphase operation, thus producing several oscillations of different frequencies in the circuits. It seems to be impossible to verify the stability by means of calculation. Without considering the difficulties arising from the large number of elements in operation, too little is known of the phenomena taking place in the triodes. In contrast to this, a quick and safe method has been obtained experimentally. In the present paper the connection devised for three tubes is fully described and the following points dealt with: (*a*) Measurement on the separate phases; (*b*) accuracy of the measurements; (*c*) radiation of a rotary field. A. E. G.

2583. *Nature of Electric Rupture.* **W. O. Schumann.** (Zeits. techn. Physik, 6. 9. pp. 439–446, 1925.)—An account is given of research carried out at Jena between 1920 and 1924 on the electric rupture of various gases, liquids and solids. Detailed descriptions of the experiments have been given in a series of papers previously published. The results obtained are now discussed with reference to the theories developed by Wagner and Rogowski. Wagner's theory appears to require extension to account for all the phenomena observed. Rogowski's theory accounts better for many of the observed effects because of the greater number of parameters involved, but certain effects, such as the polarity effect observed with a few solids, lie outside the scope of this theory. A. W.

2584. *The "End-Effect" for Stationary Electromagnetic Oscillations in a Line-Resonator.* **C. Gutton** and **E. Pierret.** (Comptes Rendus, 181. pp. 239–241, Aug. 10, 1925.)—Vibrations are induced in a system consisting of two parallel wires soldered at one end to a thermoelectric junction, and joined at a variable distance from that end by a sliding copper bridge. The system is tuned to the vibrations from a valve oscillator by moving the bridge, and the positions of resonance are observed by means of a galvanometer in series with the thermojunction. If there were no "end-effect," the length of each wire at resonance would be an exact multiple of the half-wave-length of the exciting vibration; the observed length is always shorter. The effect is small for vibrations of several metres in length, but becomes of importance for very short waves. It is shown that for an apparatus of the dimensions used, the correction in the case of a wave 22 cm. long is as much as 5 %. The determination of the magnitude of the correction may be effected by having the wires several half-wave-lengths long, and by observing the position of successive positions of resonance, but owing to the heavy damping produced the resonance curves are very flat and the method lacks precision. A better method is to map out the positions of the harmonics as previously described [see Abstract 2348 (1925)]. A calibration curve can then be drawn up showing the size of the end correction for various wave-lengths. The fundamental period of a valve oscillator when close coupled to a line resonator is not the same as that of the same oscillator

when loose coupled or coupled to an untuned circuit, but it has been observed that the period is not altered when the oscillator is coupled to a circuit tuned to one of its harmonics. Only the stability of the oscillation is diminished when the resonator is tuned to a harmonic, owing to the removal of the energy of the harmonic from the anode circuit of the valve. When in order to measure the wave-length of a feeble harmonic one is obliged to use close coupling, the length measured corresponds to the fundamental obtained not with close, but with loose coupling. T. B.

2585. *The Rotation of the Plane of Polarisation of Electromagnetic Waves by a Tetrahedral Model.* **K. F. Lindman.** (Ann. d. Physik, 77. 4. pp. 337–350, Aug., 1925.)—In a previous paper [see Abstract 2954 (1924)] the turning of the plane of polarisation of electromagnetic waves by molecular models has been described by the author. As a general result of these researches it is claimed it is possible to prove experimentally that the rotation polarisation of light by active isotropic substances can be explained as well by the presence of spiral-shaped electron paths in the molecules of these substances as by an electromagnetic turning action between atoms or groups of atoms which are conceived to be situated at the angles of the tetrahedral molecule. From this it is concluded that in an active solid body a spiral-shaped arrangement of atoms may be assumed to be the cause of turning of the plane of polarisation. [See also Abstract 1449 (1923).] A. E. G.

2586. *The Condition that the Ratio of the Intensities of the Transmitted and Reflected Electric Waves at the Interface between Two Media is Independent of their Plane of Polarisation.* **H. M. Macdonald.** (Roy. Soc., Proc. 108. pp. 386–392, July 1, 1925.)—The object of the paper is to prove that the condition necessary in order that the ratios of the intensities of the incident, transmitted and reflected electric waves at the interface between two media may be independent of the direction of the plane of polarisation of the incident waves is that the ratio of the specific inductive capacities of the two media must be equal to the ratio of their magnetic permeabilities. Conclusions are drawn as to the behaviour of the waves under different circumstances. H. N. A.

2587. *The Crookes Tube.* **A. Dauvillier.** (Comptes Rendus, 181. pp. 281–283, Aug. 17, 1925.)—In these experiments three series of measurements are taken; two at extreme pressures, compatibles with a stable functioning, and the third at a mean pressure. A table given shows the results obtained. The useful portion of kathode afflux, from the point of view of emission of electrons, seems to be always constituted of protons, whatever may be the nature of the gas contained in the tube, and the initial source of it is, at least partially, the anode. The electropositive elements contain or absorb enough hydrogen to liberate H^+ ions under the influence of the electronic bombardment due to the anodic fall. A. E. G.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

2588. *Amplification of Weak Currents and their Application to Photo-electric Cells.* **G. Ferrié, R. Jouaust** and **R. Mesny.** (Inst. Radio Eng., Proc. 13. pp. 461–470, Aug., 1925.)—An extended account in English

of methods previously described in the Comptes Rendus [see Abstract 1915 (1924)]. The apparatus is explained here in detail with the aid of photographs and diagrams. It is concluded that although only preliminary research has been conducted thus far, it seems possible that a new field has been found for photoelectric cells in astronomy. [See also Abstract 1733 (1925).] A. E. G.

2589. *The Anomaly of Dilatation of Invar.* **C. Benedicks** and **P. Sederholm.** (Ark. f. Mat. Astron. och Fysik, Stockholm, 19 B. No. 1. pp. 1–6, 1925. In French.)—Invar is not, as has been hitherto supposed, a homogeneous alloy; it contains a phase α rich in iron (kamacite) dispersed throughout the principal mass, phase γ, richer in nickel (tænite). This enables a theory at once to be framed which predicts singularities of dilatation, found to be confirmed by experiment. A. D.

2590. *Electronic Conduction in Crystals.* **B. Gudden** and **R. Pohl.** (Phys. Zeits. 26. pp. 481–483, Aug. 25, 1925.)—Refers to a recent article by Lenz, who has found that the stationary photoelectric primary current is zero in zincblende at the temperature of liquid air, and only 1/9 of its value at room-temperature in the case of diamond. Lenz claims that this proves that the photoelectric current is not due to light alone, but also requires a thermal excitation, and should be called the thermo-photoelectric current. The authors consider that the effect observed by Lenz is due to a variation in the absorption of the light with temperature. In the case of yellowish-brown NaCl crystals they have found that the curves for the photoelectric current produced in different parts of the spectrum, for equal energy of the incident illumination, are different at room temperature and at that of liquid air, the maximum being shifted in the second case towards short wave-lengths, and being actually increased. This corresponds exactly with the relation between the spectral absorption curves for these two temperatures [Abstract 1967 (1925)]. According to the wave-length employed, these curves show that it is possible for the photoelectric current to remain constant when the temperature is thus lowered, to increase, or to diminish, according to the wave-length employed. The behaviour of ZnS and diamond can also be explained in the same way, though it seems probable that some outside influence may have affected the observations of Lenz. His experiments on the effect of "shooting" kathode rays into the crystal lattice are also discussed. H. N. A.

2591. *Influence of Heat-treatment on the Thermoelectric Properties of some Steels.* **P. Nicolau.** (Rev. de Mét. 22. pp. 539–544, Aug., 1925.)—For the testing of steels after various heat treatments, the author recommends the measurement of the thermoelectric force as suitable for the workshop. The Brinell test is not always satisfactory, and the more precise methods of change in electrical resistance or alteration in magnetic properties demand apparatus not always available. In the arrangement described in this paper the bar under test is clamped at one end in a water-cooled steel vice, while the other end dips in a mercury bath, electrically heated and kept at a temperature of 120° C. The other element of the couple is a steel wire, with one end in the mercury bath, the circuit being completed through a millivoltmeter. Data for various steels are given and graphs show the changes in thermoelectric force for quenching at

various temperatures in water or oil. These consist of two straight portions, the change being constant when the quenching temperature is above 200°–300° C. The temperature at which the change in shape occurs for any sample corresponds approximately to the quenching temperature at which the Brinell hardness number alters for that sample. L. L.

2592. *The Lattice Theory of Piezoelectricity.* **G. Heckmann.** (Zeits. f. Physik, 33. 8. pp. 646–647, 1925.)—A correction of a formal error in Born's explanation of piezoelectricity in crystals by means of the lattice theory. According to Born, an electric dipole or quadrupole moment can only be produced in a crystal by elastic deformation when an inner shift of the different ionic lattices with regard to one another is coupled with the deformation. This, however, is only true for those crystals in which the Cauchy relations between the elastic constants are not satisfied. It is clear that a crystal which, when undeformed, has an electric moment will acquire an additional moment when elastically deformed—for instance, by compression in all directions—since the moment alters with the dimensions of the crystal. H. N. A.

2593. *Optical Methods of Demonstrating High-frequency Longitudinal Oscillations of Piezoelectric Crystal Rods.* **E. Giebe** and **A. Scheibe.** (Zeits. f. Physik, 33. 5–6. pp. 335–344, 1925. From the Reichsanstalt.)—The arrangement employed was similar to that used by Cady [see Abstracts 66 B (1923) and 2015 (1922)], except that between the quartz rods used and the lower electrode a space of about 0·5 mm. was left, and the crystal and electrodes were contained in a glass tube exhausted to a pressure of about 10 to 15 mm. of mercury. At the resonance frequency the space between the crystal and the lower electrode became luminous, the length of the luminous glow decreasing as the applied frequency differed more from the resonance frequency. Photographs are reproduced of the effects obtained at the fundamental frequency and at harmonic frequencies. Harmonics up to the 15th were observed in this way. A. W.

2594. *Qualitative Examination of the Piezoelectric Properties of Crystals.* **E. Giebe** and **A. Scheibe.** (Zeits. f. Physik, 33. 10–11. pp. 760–766, 1925. From the Reichsanstalt.)—A simple method is described for examining qualitatively the piezoelectric properties of crystals. The method is applicable to very small quantities of the substance and to very small crystals. It consists essentially in setting up in the crystals elastic oscillations by means of high-frequency alternating electric fields in a manner similar to that described by Cady [Abstract 2015 (1922)]. The crystals may consist of a large number of irregularly formed and oriented small crystals or crystal splinters. Observations are made by means of telephones connected to a receiver coupled to the valve generator. When the frequency of the latter is varied a ringing noise is heard on passing through the resonance frequency of the crystals. A table is given of results obtained by the method with crystals of a number of different substances. [See preceding Abstract.] A. W.

2595. *Increasing the Working Range of an Oscillograph.* **C. E. Wynn-Williams.** (Phil. Mag. 50. pp. 1–26, July, 1925.)—With all types of oscillograph which employ a mechanical system the usefulness of the instrument is limited by the frequency range over which accurate results

are obtainable. The extent of this range depends upon (1) the type of oscillation to be studied, (2) the maximum error permissible, and (3) the natural frequency and damping of the instruments. It can easily be shown that under ordinary conditions the natural frequency of the oscillograph must be from five to ten times that of the highest frequency to be recorded. With the majority of mechanical oscillographs (*i.e.* including kathode-ray oscillographs) this usually involves great loss of sensitivity at high frequencies, say of the order 10^4. The author now describes various electrical systems (involving suitable adjustment of inductance capacity and resistance) whereby an oscillograph (*e.g.* an Einthoven string type) may be compensated by reducing the amplitude scale for the lower frequencies and increasing it for the higher frequencies, thus enabling the frequency range to be increased. This is done by subjecting the oscillograph to a fraction of the quantity to be examined and making this fraction a function of the frequency, this fraction being large at high frequencies and small at low frequency. The form of function required to secure this compensation is determined mathematically and verified by experiment. The method is applied to both potential and current oscillographs, and a number of oscillograms are reproduced in illustration.

A. B. W.

2596. *Method of Comparing Inductance and Capacity.* **T. B. Vinycomb.** (Phil. Mag. 50. pp. 439–444, Aug., 1925.)—Ganguli's work (*ibid.*, p. 165, Jan., 1925) on Forsythe's method for comparing self-inductance and capacity [see Abstract 1724 (1913)] is criticised. The deduction advanced by Ganguli is correct, but the method of proof conceals to some extent the principle of the measurement. Under the conditions employed a balance is obtainable with alternating current only when the fourth arm of the bridge, containing the inductance and the capacity, is non-reactive, that is, behaves as a pure resistance, the bridge network being used merely to determine when this condition is fulfilled. There is no need to "swamp" the resistance of the inductance L, as suggested by Ganguli, and when $Q^2 = r^2 = \frac{L}{C}$, the resistance s is not required except to obtain a balance on the bridge and should be omitted, as it reduces the sensitiveness; the balance may be obtained by varying S. For ordinary values of the quantities concerned: (1) the value of r is not critical and may be left for final adjustment; (2) the method is not sensitive for small values of $\frac{C}{L}$, which require C to be large; (3) the direct current balance must be adjusted as accurately as possible if a good silence is to be obtained with alternating current—for instance, by a slide wire in the arm S. If these points are taken into account, it is not difficult to obtain results concordant to less than 0·25 % and in agreement with measurements made by other methods.

T. H. P.

2597. *Electrostatic Voltmeters and Slow Tubes for High-frequency Pressure Measurements.* **A. Palm.** (Zeits. f. Hochfrequenztechn. 26 1. pp. 13–16, 1925.)—A description is given of electrostatic voltmeters for low and very high voltages manufactured by Hartmann and Braun for high-frequency work, the effect of the various capacities on the accuracy of the instruments being considered. The present form of the tubes used

in the measurement of peak voltages is described [Abstract 2266 (1923)], and the method of making such measurements. E. M.

ALTERNATING CURRENTS AND MAGNETISM.

2598. *Passage of an Alternating Current through Sulphuric Acid.* **R. T. Lattey.** (Phil. Mag. 50. pp. 444–453, Aug., 1925.)—The relationships between capacity (C), resistance (S), current strength, and periodicity (p) during the passage of an alternating current through aqueous sulphuric acid of maximum conductivity have been investigated for values of p between 25 and 500 for four pairs of platinum electrodes. The law connecting capacity and periodicity seems to be $pC = A + pB$, and that connecting resistance with periodicity $pS = D$, where A, B and D are constants depending on the nature and condition of the electrode surfaces. T. H. P.

2599. *Current Distribution in Cylindrical Conductors.* **F. Fischer.** (Zeits. f. Physik, 33. 8. pp. 623–627, 1925.)—The current distribution in cylindrical conductors of non-circular section has been experimentally investigated, both as regards magnitude and phase, by Reich and Fischer [see Abstract 1388 B (1925)]. In the present paper it is shown that in previously published theoretical treatments of the subject, in particular that of Lampa for elliptical sections and that of Edwards and Press for rectangular sections, certain mistakes occur. A. W.

2600. *Measurement of the Current Distribution in a Conductor carrying Alternating Current.* **H. Busch.** (Phys. Zeits. 26. pp. 509–514, Sept. 7, 1925.)—In the conductor, which should be as large as possible, a long narrow slot is cut. In the experiments described the conductor was a cylinder 2 cm. diameter and the slot, which passed through the axis, was 1 mm. or 0·75 mm. wide and 15 cm. long. The probe introduced into this slot consisted of a slip of insulating material, carrying a longitudinally stretched wire with sliding contacts at the ends. The wire was divided at the centre and twisted leads brought out at right angles to an arrangement for measuring the potential difference between the ends and also the phase. The sources of error are discussed and curves are given showing the results obtained. [See preceding Abstract and 1388 B (1925).] A. W.

2601. *Jumping Phenomena in Ferro-resonance.* **Y. Watanabe.** (Tôhoku Univ., Technol. Reports, 5. 1. pp. 11–27, 1925. In English.)—Theoretical and also graphical methods for explaining the jumping phenomena in ferro-resonance are first given, and then experiments are described in verification. The effects due to variations of resistance, capacity and inductance of the circuit are shown by a series of interesting diagrams, and Braun-tube oscillograms are also given. A. W.

2602. *Regarding Abruptly-beginning Magnetic Disturbances.* **L. A. Bauer** and **W. J. Peters.** (Terrest. Magn. 30. pp. 45–68, June, 1925.)—Several recent investigations have indicated that the earth's magnetic field has an appreciable effect on the electric waves used in wireless telegraphy and that there is a distinct relationship between terrestrial magnetic disturbances and certain radio phenomena. In view of these facts and of an

action taken at the Madrid meeting of the International Section of Terrestrial Magnetism and Electricity, last October, a preliminary investigation was made by the authors regarding the outstanding question as to the simultaneity, or non-simultaneity, of abruptly-beginning magnetic disturbances, the definite settlement of which is likely to have an important bearing on the theory of the earth's magnetic storms and their connection with the phenomena of radio-telegraphy, noted above. The present preliminary communication is an extension of the first author's investigations of 1910. The present results apparently indicate that even with the aid of the magnetograms ordinarily obtained at magnetic observatories, appreciable differences in the absolute times of beginning of abrupt disturbances can be detected, which, on the average, increase with increasing magnetic latitude, the correlation coefficient being about 0·75. The average speed of progression, as derived from thirty abrupt disturbances, during periods of high and low sunspot activity, apparently would be 100 cm. per sec., so that the uninterrupted progression of an average abrupt disturbance, from the magnetic equator to the magnetic pole, might take about 1·8 min. These results are regarded merely as a working hypothesis for further examination when more extensive data are available. AUTHORS.

2603. *Relationship between the "Solar Constant" and Terrestrial Magnetism.* **C. Chree.** (Roy. Soc., Proc. 109. pp. 1–6, Sept. 1, 1925.)—Abbot has recently issued values of the "solar constant" for a period of about the last four years. An endeavour is here made to see whether there is any parallelism between the variation of the "solar constant" and variation of the terrestrial magnetic elements. In particular the 27-day period so marked in the magnetic elements has been looked for in the "solar constant," but no such periodicity is observed. It is also concluded that there is no recognisable relation between the value of the "solar constant" and the magnetic character either on the same day or on the following day. A. A. D.

2604. *Measurement of Local Variations of the Earth's Field, using an Earth Inductor.* **H. Haalck.** (Zeits. techn. Physik, 6. 8.pp. 377–380, 1925.)—Two precisely similar earth inductors are fastened rigidly at either end of a shaft 2 metres long. The inductors are in series and wound in opposite directions. When the shaft is suitably placed in a uniform field and rotated no sound is heard in the telephone connected to the coils, but if the field is different at the places where the coils are situated there is a resultant effect. The apparatus may thus be used to determine the presence of masses of iron below the surface of the earth. Details of how to do this are given. By a slight modification iron ships on the sea bottom can be located. A. A. D.

2605. *Electromagnetic Fields in Laminated Iron.* **O. Betz.** (Zeits. f. Hochfrequenztechn. 26. 2. pp. 29–37, 1925.)—A lengthy mathematical investigation on high-frequency electromagnetic fields in laminated iron. E. T. A. R.

2606. *Some Further Experiments on the Gyromagnetic Effect.* **J. W. Fisher.** (Roy. Soc., Proc. 109. pp. 7–27, Sept. 1, 1925.)—Experiments are described in which it is sought to detect a gyromagnetic effect by

magnetising a substance (in most cases magnetite) by a rotating magnetic field, and looking for a component of magnetisation in a direction perpendicular to the plane of rotation of the field ; such a component would be expected to arise if a rotation of the magnetic axes of the molecule is set up by the rotating field. Fields rotating at frequencies of $2–5 . 10^4$ cycles per sec. were produced by valve generators, but no evidence of an effect of this kind was found, even for rotating fields of over 100 gauss. The magnitude of the effect to be expected has been calculated and the sensitivity of the apparatus was such that it should have been easily capable of detection if present. AUTHOR.

2607. *Apparatus for the Determination of Hysteresis Coefficients.* **A. Blondel.** (Comptes Rendus, 181. pp. 234–236, Aug. 10, 1925.)—This is an improvement upon an apparatus described previously (*ibid.*, 127. p. 957, 1898). It consists of a rotating horseshoe magnet between the poles of which, resting upon a separate table, is placed a pile of rings under test. This supporting table is prevented from rotating by means of a spring. The tension in this spring is measured as the magnet turns, and from the observations the coefficient η in Steinmetz's formula can be found. In the present form only two rings of material under test are used, instead of a larger number as in the previous apparatus. This leads to a considerable increase in induction. In addition the magnet is fitted with a variable magnetic shunt.

By the above method the hysteresis losses during rotation are obtained. A modification is described by which the alternating losses may be determined for rods. A. A. D.

2608. *Methods for Measuring the Effect of Temperature on Magnetic Properties.* **E. M. Terry.** (Optical Soc. America, J. and Rev. Sci. Inst. 11. pp. 67–74, July, 1925.)—Up to the Curie point the most suitable method is the ballistic one, making use of a ring of the material under test. The best way to wind the ring, and the most convenient way to heat it, are described. For work above the Curie point the magnetic torsion balance is used and the type used by the writer is described. This can be used both for vacuum work and for high-temperature work. For magnetic changes of length at high temperature the method of Honda and Shimizu is suggested (Journ. Sci. Coll., Tokyo, 19. 1903–1904). This is based on the use of an optical lever. A slight modification of this apparatus enables the Wiedemann-effect to be measured. For low-temperature work, in fields below 150 gauss, the ring method is the best. Details of the method used by Knipp [Abstract 229 (1903)] are given. For stronger fields at low temperature the ellipsoid method devised by Weiss (J. de Physique, Ser. 4. vol. 6, 1907) and used by Onnes is recommended. A. A. D.

2609. *Non-Magnetic Sputtered Films of Nickel.* **L. R. Ingersoll** and **S. S. de Vinney.** (Phys. Rev. 26. pp. 86–91, July, 1925.)—(1) *Magnetic.*—These films, prepared by sputtering in hydrogen on to a cooled surface, with a 1000-volt d.c. generator, are initially non-magnetic, showing neither magneto-optic rotation nor tractive effects in a magnetic field. After heating to 300° or 400° C., however, they become strongly magnetic, and exhibit both these effects. Films much thicker than 120 $m\mu$, or those sputtered with an induction coil, are likely to be magnetic from the start. (2) *Crystal structure.*—X-ray spectrograms by the powder method show

for the heat-treated (magnetic) film the face-centred cubic lattice as for ordinary nickel, but prove that the original non-magnetic film is amorphous. These facts suggest that ferro-magnetism, in nickel at any rate, is not a property of the individual atom as customarily supposed, but of the crystalline aggregate. A number of possible objections to this point of view are taken up and discussed. (3) *Electric.*—The gain in magnetic properties on heat-treatment is accompanied by a decrease of resistance to a fraction (a fifth in one case) of its initial value. The original film also gives only about 1 % of the Hall-effect that it does after heat-treatment. (4) *Colour.*—Some films, particularly those deposited on a surface at liquid-air temperatures, display remarkable colours. On examination of the reflected light with a spectroscope, only a narrow spectral region is seen to be absent. If the nickel films are thin, covering with an optically dense liquid completely destroys the colours. AUTHORS.

2610. *Contribution to the Study of Magnetic Induction.* **J. Schwarz.** (Rev. Gén. d'Él. 17. pp. 145–151, July 25, 1925.)—An analytical expression is obtained for the virgin part of the B–H curve and is applicable to any ferromagnetic substance, under choice of suitable constants. The method of attack is as follows: The value of dB/dH passes through a maximum, falls to zero, and then mounts asymptotically to the value $+1$. The value of d^2B/dH^2 starts with zero value and has two maxima and one minimum value, finally falling to zero asymptotically. These deductions are at once apparent if one considers the characteristics of the family of curves to which every B–H curve belongs. A differential equation is now given which satisfies the conditions outlined above, and its solution gives B as a function of H. The greater part of the paper is mathematical and is not suitable for abstraction. It is claimed finally that the results obtained justify certain views advanced by Vaschy to the effect that as the field increases the magnetic intensity may reach a maximum and then fall to zero or below, in which case the metal will have suffered an internal modification under the action of the field by becoming diamagnetic. A. A. D.

2611. *Magnetisation of Ferro-Magnetic Substances by Rotation and the Nature of the Elementary Magnet.* **S. J.** and **L. J. H. Barnett.** (Am. Acad., Proc. 60. pp. 127–216, July, 1925.)—In earlier papers [see Abstract 1761 (1915)] it has been shown that the rotation of iron, cobalt or nickel about a fixed axis in a magnetically neutral region at an angular velocity of N revs. per sec. magnetises the substance as it would be magnetised, at rest, by the application of an axial magnetic field with intensity $H_r = \lambda N$, where λ, within the limits of experimental error, is constant for any one substance and identical for all the substances investigated. The quantity λN is referred to as *the intrinsic magnetic intensity of rotation.* For experimental details and description of apparatus and methods reference must be made to the original paper. The value of λ finally obtained (a mean of 159 sets of observations) is $-3{\cdot}76 \times 10^7 \pm 2\ \%$. A. B. W.

2612. *A Hysteresigraph with Two Mirrors at Right Angles on Synchronous Damped Coils.* **C. Lapp.** (J. de Physique et le Radium, 6. pp. 166–176, May, 1925.)—A small vertical coil carries a constant current from an accumulator, and moves in the variable magnetic field

in the air-gap between the poles of the nearly complete ring of iron under test. The mirror attached to this coil throws a beam of light on to a long rectangular mirror attached to a horizontal coil, which carries a portion of the magnetising current; this mirror throws the beam on to a photographic plate, or a ground-glass plate carrying a piece of transparent paper, on which the hysteresis curve can be pencilled. The natural periods of swing of the two coils (1/20 sec.) mnst be adjusted so as to be identical within 1/200, and the damping must be the critical damping. It is possible to employ frequencies up to 15 per sec. It is shown that the effect of the air-gap can be taken into account by means of a graphical method. Although the iron rings employed were not laminated, the enlargement of the hysteresis curves when the frequencies were increased could not be attributed to eddy currents, since these were very small at the highest frequencies used; the increase in the area of the cycle at the higher frequencies is attributed to magnetic viscosity. H. N. A.

RADIOGRAPHY AND ELECTRO-PHYSIOLOGY.

2613. *Photometry of X-Ray Fluorescent Screens.* **L. A. Levy** and **D. W. West.** (Brit. J. of Radiology, 21. pp. 104–118; Disc., 119–123, July, 1925.)—The requirements of fluorescent screens for visual purposes are brightness, contrast, sharpness, and resolving power. Only one of these requirements—namely brightness—is capable of quantitative measurements, the others involving psychological factors of the particular observer. A description of the relative properties of the more commonly used fluorescent materials—namely barium platinocyanide, willemite, and cadmium tungstate—is given, followed by particulars of a photometric bench used in the experiments made. These experiments consisted of determination of (1) variation of illumination with voltage, (2) variation of illumination with current, (3) variation with thickness of screen coating, (4) comparison of gas and Coolidge-tube fluorescence, (5) effect of filters upon the luminosity, (6) effect of varying the conditions of operation of a mercury break, (7) comparison of transformer and coil outfits, (8) use of Wehnelt's break, (9) actual candle-power of a screen surface, found to be 0·14 candle per sq. ft., (10) absorption of light by bad gloss cover. The conclusions are summarised, and amongst the most important conclusions may be noted that the cadmium tungstate screen is considered to be generally superior to the barium platinocyanide screen, a gas tube superior to the Coolidge tube, and the coil superior to the transformer, regarded from the points of view of illumination. A screen should not be backed by aluminium, which absorbs the softer fluorescing radiations. Lead glass protection is only objectionable in the case of willemite screens. An extended discussion followed. B. J. L.

CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

2614. *Constant N of Avogadro.* **P. L. du Noüy.** (Phil. Mag. 50. p. 504, Aug., 1925.)—Alexander's criticisms [see Abstract 1752 (1925)], the author's work [see Abstract 431 (1925)] are admitted, and it is pointed out that the value of N should be $6{\cdot}004 \times 10^{23}$, not $6{\cdot}003 \times 10^{23}$. T. H. P.

2615. *Preparation and Analysis of Constant Mixtures of Air and Carbon Dioxide.* **J. Johnston** and **A. C. Walker.** (Am. Chem. Soc., J. 47. pp. 1807–1817, July, 1925.)—Marked changes in the direction or velocity of the wind may be accompanied by variations in the carbon dioxide content of the air, but the magnitude or direction of the changes cannot be predicted from a study of wind conditions. An apparatus is described for the preparation of flowing mixtures of air and carbon dioxide having any given concentration of the components from values as low as 50 parts per 1,000,000, with a variation not exceeding 10 parts per 1,000,000 over a period of several days. The air and carbon dioxide, under constant pressures, stream past the two surfaces of a thin rubber diaphragm. The carbon dioxide diffuses through rubber several times as fast as air, and the rubber sheet serves to regulate the mixture of the gases. Reasonable variation in the pressure, and hence in the rate of flow, of the carbon dioxide is without effect on its concentration in the resulting mixture, provided that the rate of flow of the air is constant. Pettenkofer's method for the determination of carbon dioxide in air is modified to increase its accuracy, especially when the proportions are very small. T. H. P.

2616. *Celtium.* **J. Bardet** and **C. Toussaint.** (Comptes Rendus, 180. pp. 1936–1938, June 22, 1925.)—Method for separation from zirconium, based upon the difference of solubility of the phosphates in sulphuric acid. Tabulation, corrected, of the spectral lines of celtium. A. D.

2617. *Adsorption and Surface Energy at the Boundaries of Different Phases.* **B. Iliin.** (Phys. Zeits. 26. pp. 497–501, Aug. 25, 1925.)—The formula of Szyszkowski, which expresses the relationship between the surface tension σ, and the concentration c, $\sigma(c) = \sigma(o) - b \log_{10}(ac + 1)$, is combined with the equation of Gibbs, whereby an equation for the adsorption is obtained, $T = T_m(1 - e^{-\omega c})$, where T is the adsorption capacity and ω a constant. The formula is modified, and experimental results of Titoff, on the heat of adsorption, of nitrogen, carbon dioxide, and ammonia, and the results of Lamb and Coolidge on the heat of adsorption of carbon bisulphide, are used to confirm the mathematical conclusions. [See also Abstract 2372 (1925).] F. J. B.

2618. *Molecular Weight Determination in Mixed Solvents.* **C. Drucker.** (Zeits. Elektrochem. 31. pp. 409–412; Disc., 412, Aug., 1925. Paper read before the Deut. Bunsen Gesell., Darmstadt, May, 1925.)—A series of experiments was carried out to determine the change of boiling-point when various substances were dissolved in a mixed

solution of CS_2 and CH_3OH using the apparatus described earlier [Abstract 806 (1911)]. Different concentrations of solute were employed and different proportions of CS_2 and CH_3OH. It was found that the Nernst theory of boiling did not hold under these conditions and that a change in the composition of the vapour produced by the solute was the cause. Six different solutes were tested, each producing a change in the partial pressure of the component solvents in consequence of their different solubilities in the two solvents. Further, the change of composition of the vapour is in close agreement with the influence on the mixing temperature, which becomes displaced by the solute towards the value shown by the mixed solvents over which the vapour has the same composition as over the given solution. R. S. R.

2619. *The Heats of Solution of Enantiotropic Modifications at the Transition Point.* **E. Cohen** and **H. L. Bredée.** (Zeits. phys. Chem. 117. pp. 143–155, Aug. 10, 1925. K. Akad. Amsterdam, Proc. 28. 6. pp. 573–586, 1925.)—Experimental proof is now afforded for the proof of the tangent law of le Chatelier, $(dc/dT)/(dc'/dT) = L/L'$, where dc/dT and dc'/dT, L and L′ represent temperature coefficients of solubility and heats of solution respectively. The previous unsatisfactory result of Mondain-Monvel [see Abstract 1479 (1923)] is shown to be due to insufficient experimental accuracy. H. H. Ho.

2620. *The Composition of Soap Films.* **Mary E. Laing.** (Roy. Soc., Proc. 109. pp. 28–34, Sept. 1, 1925.)—Bragg has stated [Abstract 1414 (1925)] that the black spot of soap films is due to a molecular film of oleic acid. The present author has investigated the composition of such films by means of chemical analysis, electrical conductivity and refractive index. A description of the apparatus used to avoid secondary chemical changes is given, together with experimental results. These show Bragg's view is correct that the black spot is due to the actual contact of two molecular layers, but these adsorbed layers are acid sodium soap, probably hydrated, instead of fatty acid. The stability of soap films is more readily understood if they are made of this colloidal material rather than a pure liquid, as oleic acid. B. J. L.

2621. *Hydration of Ions, Colloids, and Gels.* **N. R. Dhar.** (Zeits. Elektrochem. 31. pp. 261–283, June, 1925.)—A critical summary is given of the investigations made on this subject during the past few years, some of the main conclusions drawn being as follows: Dehydration plays an important part in the ageing of sols prepared chemically and of colloids in plants and animals. The dehydration of gels and freshly precipitated substances is accompanied by diminution in the chemical reactivity. The formation and stability of minerals and rocks are related to the hydration and dehydration of sols and gels. Soap nuclei are probably hydrated, and the proteins and other hydrophile colloids are certainly more highly hydrated than the hydrophobe colloids. It is generally admitted that the hydration of colloids is connected with an increase in the viscosity, and the results of measurements of the viscosity indicate that hydrophile colloids are usually hydrated. Further, in some instances vapour-pressure measurements show the existence of definite hydrates. There seems no doubt that the phenomena of adsorption play a predominant part in many processes in which water is taken up.

The view is advanced that the maximum viscosity and the minimum hydration correspond with the neutralisation of the charges of the colloid particles, explanations of many of the phenomena of colloidal chemistry being possible in accordance with this view. The behaviour of colloids on coagulation by mixtures of electrolytes gives no indication of the condition of their hydration. T. H. P.

2622. *X-Ray Examination of some Alloys.* **A. Sacklowski.** (Ann. d. Physik, 77. 3. pp. 241–272, Aug., 1925.)—The investigations have been made by the powder method, the actual experimental arrangement being based upon that devised by Bohlin and Seemann. Full details of the apparatus are given. As is known, the alloys of silver and copper yield a eutectic at about 40 % (atomic) of copper. In addition copper is soluble in silver up to about 10 % and silver in copper up to about 3 %. The results are as follows: Up to 9·2 % of copper the spectrogram, only shows the lines for silver. From 16 % to 80 % of copper the lines of both elements appear. From 93·5 % to 100 % only the copper lines are present. Over the ranges of solid solution at the two ends of the diagram, Vegard's addition law for the lattice constant is satisfied with some accuracy. The nickel copper alloys give a continuous range of solid solutions. Here again Vegard's law is satisfied, but owing to the fact that the two constituent elements have very nearly the same lattice constant, the test is not very sensitive. The X-ray analysis gives no support to the view that there is any intermetallic compound between copper and nickel. Between 60 % and 100 % of nickel these alloys are magnetic, but this property does not appear to affect the lattice in any way. The lead-magnesium system shows a eutectic range at either end, together with an intermetallic compound $PbMg_2$. X-ray analysis shows that this compound is a face-centred cube with a lattice constant of 6·76 Å.U. In the same way the presence of the compound $SnMg_2$ in the tin-magnesium system is shown to be face-centred with a constant of 6·75 Å.U. A. A. D.

2623. *High-frequency Fatigue Tests.* **C. F. Jenkin.** (Roy. Soc., Proc. 109. pp. 119–143, Sept. 1, 1925.)—A record of experimental work on high-frequency fatigue of copper, Armco iron and mild steel. The paper mentions the work of Hopkinson and Stanton and adopts a new method of test. A vibrating spring formed the test piece maintained in resonant vibration by means of an electromagnet in a tuned circuit containing a thermionic valve. All test pieces were of same length and so mounted as to obviate stresses at the points of support. Full experimental details are given and the results given in series of tables and curves. The results confirm Hopkinson's anticipation, but show that effect of speed is very much less than was suggested by his experiments. Materials gain slightly in their fatigue-resisting power with increase of speed, but in practice the gain is insignificant. The effect of speed of testing on the results is also trifling at any of the ordinary speeds. High-frequency vibrations superposed on the ordinary load, on account of their high frequency, have little serious effect, hence vibrations in the testing machine have no deleterious effects. The effect of such vibrations may be estimated from the additional load in the test piece. It is also shown that the mechanism of fatigue requires time. At high speeds, loads which are sufficient to cause fracture have not time to produce

the effective cause of fracture, and higher loads are necessary to produce this effect. Part II describes an attempt to increase the speed of alternation. The original apparatus was unsuitable, since increment of speed meant decrement of length of sample until electromagnetic force could no longer be used. A new apparatus using torsion was devised, full details of which are given, but no samples under test were broken by it. The paper concludes with an appendix giving the mathematical treatment of the principles involved. S. G. B.

2624. *The Growth of Metal Crystals from the Gas Phase.* **H. Fischvoigt** and **F. Koref.** (Zeits. techn. Physik, 6. 7a. pp. 296-298, 1925.)—Koref has shown that a tungsten monocrystal wire, when heated in an atmosphere of hydrogen and tungsten hexachloride, grows as a monocrystal, but is brittle until heated to white heat, when it becomes ductile. The authors find that when the gaseous mixture contains a larger proportion of hydrogen the crystal is ductile as originally prepared. Van Arkel has obtained a ductile growth by using tungsten hexachloride without hydrogen, the wire being heated to 1600–1700° C. Other metals can be deposited on a tungsten monocrystal wire from the gas phase, growing upon it as monocrystals; they must have volatile chlorides and high melting-points; the edge of the lattice element must not differ too much from that of tungsten, but it is not essential that the lattice type should be the same as that of this metal. The experiments were successful with molybdenum ($a = 3{\cdot}143$) and tantalum ($a = 3{\cdot}272$), both of which, like tungsten ($a = 3{\cdot}18$), are cubic space-centred; the crystals grew with well-marked edges, and could be bent without any heat treatment. Vanadium ($a = 3{\cdot}04$), which is also cubic space-centred, gave an unoriented microcrystalline growth; this seems to be due to the 4·4 % difference between the a values of the two metals. Zirconium and titanium are both deposited, though they belong to the hexagonal type; the growth has sharp edges. When bent the growth split into long strips, which separated from the tungsten; the strips could be bent. H. N. A.

2625. *The Formation of Ozone in Incandescent Capillaries.* **E. H. Riesenfeld.** (Zeits. Elektrochem. 31. pp. 435–440; Disc., 440, Aug., 1925. Paper read before the Deut. Bunsen Gesell., Darmstadt, May, 1925.)—Full details are given of the experimental method used to examinine the ozone produced when oxygen is drawn through a heated quartz capillary tube. Tabulated results show that the partial pressure of the resulting ozone increases with rise of temperature and with the rate of the flow of the entering oxygen. The possible causes for the formation of the ozone, such as electrical, photochemical, chemical or mechanical action, are considered, and one or more of these causes may be in operation. A film is supposed to form over the surface of the quartz in which the concentration of ozone is much higher than in the general stream of oxygen, and the depth of this film is altered by different rates of flow. This method of excessive concentrations may serve also for the production of other substances. R. S. R.

2626. *Mechanism of the Fixation of Nitrogen as Sodium Cyanide.* **E. W. Guernsey** and **M. S. Sherman.** (Am. Chem. Soc., J. 47. pp. 1932–1940, July, 1925.)—The formation of sodium cyanide when a mixture of

sodium carbonate, carbon, and iron catalyst is heated in nitrogen takes place through (1) reduction of the sodium carbonate to metallic sodium, (2) formation of sodium carbide from its elements, (3) absorption of nitrogen by (gaseous) sodium carbide to form sodium cyanide. Iron exerts a marked catalytic effect on the absorption of nitrogen by sodium carbide, but does not appear to be essential for the reduction of sodium carbonate or for the formation of sodium carbide. T. H. P.

2627. *Transference Numbers of Solutions of Mixed Chlorides.* **D. A. MacInnes.** (Am. Chem. Soc., J. 47. pp. 1922–1927, July, 1925.)—Re-examination of the results of measurements of transference numbers of solutions containing sodium and potassium chlorides made by Braley and Hall and by Schneider and Braley [see Abstract 2334 (1923)] leads to the conclusion that the data published by these authors are in accord with the assumption that simple ions only are present in the solutions. The experimental errors are, however, large in some cases. [See next Abstract.] T. H. P.

2628. *Transference Numbers of Sodium and Potassium Chlorides and of their Mixtures.* **Jane Dewey.** (Am. Chem. Soc., J. 47. pp. 1927–1932, July, 1925.)—Repetition of Schneider and Braley's work on solutions containing sodium and potassium chlorides [see Abstract 2334 (1923)] fails to confirm the result that with a low proportion of sodium chloride the transference number of the sodium-ion constituent falls nearly to zero. The results now given are in close agreement with the assumption that simple ions alone, and no complex ions, are present in the solutions. T. H. P.

2629. *Influence of Water on Certain Chemical Reactions. I. Effect of Various Concentrations of Water-Vapour on the Reaction of Chloride with Potassium Iodide or Bromide. II. Reaction between Hydrogen Sulphide and Iodine in Ether. III. Reactions between certain Metals and Iodine.* **L. B. Parsons.** (Am. Chem. Soc., J. 47. pp. 1817–1835, July, 1925.)—I. For each temperature, a definite minimum partial pressure of water-vapour must be attained before any considerable reaction takes place between chlorine and potassium iodide or bromide, this pressure being approximately the vapour-pressure of a saturated solution of the components present during the reaction. II. The reaction between hydrogen sulphide and iodine in ethereal solution proceeds to completion in absence of water in accordance with the equation, $H_2S + I_2 = 2HI + S$. When water is present, the reaction, $H_2S + 3H_2O + 3I_2 \rightleftarrows H_2SO_3 + 6HI$, is probably the resultant of three separate reactions, and is incomplete, the equilibrium point reached being dependent on the relative concentration of the water. The reaction is not appreciably affected by diffused daylight, but air must be excluded, since oxygen changes the nature of the reaction, probably owing to the formation of ether peroxide. III. The results of experiments on mixtures of various metals and iodine to which organic liquids of widely different characters are added, reveal a close parallelism between the ability of a liquid to bring about the reaction between metal and iodine, and the solubility of the metallic iodide in the liquid. The function of the liquid is to dissolve the film of solid iodide, and thus lay bare the surface of the metal. T. H. P.

2630. *Decrease in Electromotive Force of Unsaturated Weston Cells.* **W. G. Vosburgh.** (Optical Soc. America, J. and Rev. Sci. Inst. 11. pp. 59–61, July, 1925.)—It is very desirable to know the rate of decrease of unsaturated cells. As a result of experiments this rate was found to be very slow. Some cells that had been standing for a year or more showed an average of 0·04 mv. or 0·004 % in a year. The factors of most influence in determining the rate of decrease must be the distance between the mercurous sulphate and the amalgam, the cross-section of the connecting tube and the presence or absence of obstructions to diffusion. Tables are given of results on non-portable cells with electrolytes of different cadmium sulphate concentration, and portable cells with coarse and fine mercurous sulphate. T. C. H.

2631. *Activity Coefficients.* **E. Wilke** and **O. Kieninger.** (Zeits. phys. Chem. 116. pp. 215–226, June 15, 1925.)—The influence of hydrochloric acid on the e.m.f. of the hydrogen electrode agrees approximately with the Nernst formula, but this is not the case with chlorine electrodes, the e.m.f. with 5-N hydrochloric acid in the variable half-cell being about four times the calculated value. When a hydrogen-chlorine cell is subjected to the action of an applied current, the potential displacement of the hydrogen electrode increases with the dilution of the hydrochloric acid or sodium chloride, the reverse taking place with the chlorine electrode. T. H. P.

2632. *Electromotive Force of Filtration.* **L. Riéty.** (Comptes Rendus, 180. pp. 2026–2027, June 29, 1925.)—Of a number of salts of iron examined, in the manner previously described [see Abstract 2822 (1924)], those which give solutions negatively charged on issuing from the capillary tube are salts of monobasic acids, whereas, with the exception of iron lactate, solutions of salts of dibasic or tribasic acids become positively charged. This phenomenon is due to the fact that the layer of liquid in contact with the glass becomes basic owing to electrolysis of the alkaline silicates of the glass, the glass itself consequently assuming a negative charge. With solutions of mercuric chloride and cyanide, which resist hydrolysis, comparatively high positive potentials are obtained. T. H. P.

2633. *Dissolution of Nickel in Sulphuric Acid under the Influence of Alternating Current.* **A. P. Rollet.** (Comptes Rendus, 180. pp. 2047–2049, June 29, 1925.)—When an alternating current of 50 periods is passed between nickel electrodes immersed in a large volume of sulphuric acid kept thoroughly stirred, the volume of hydrogen liberated corresponds exactly with the weight of nickel dissolved. Increase in the rapidity of stirring results in increase of the yield, and as the temperature of the liquid is raised, the yield increases to a maximum at 30° and then diminishes, the value at 65° or 70° being lower than that obtained at 0°. With low current densities, the yield increases to a constant value with increase in the concentration of the acid, but with higher current densities the yield advances more slowly and becomes constant only for high concentrations. The yield rises with the current density to a value lying between 0·7 and 1·5 amp. per sq. cm., hydrogen alone being evolved; with further increase in the current density the yield falls off steeply and a mixture of hydrogen and oxygen is liberated. T. H. P.

2634. *Laboratory Apparatus for Various Anode Processes (Formation of Bichromates, Persalts, Chloroform, etc.).* **I. Stscherbakoff.** (Zeits. Elektrochem. 31. pp. 360–362, July, 1925.)—In order to eliminate the harmful influence exerted by the bases formed at the kathode during the electrolysis of salts of the alkalies a mercury kathode enclosed in a porous pot is employed. This is so arranged that the metal deposited forms an amalgam with the mercury, which rises to the surface, where it is decomposed by water in a chamber sealed from the rest of the apparatus by a glass cylinder dipping below the surface of the mercury. By using this apparatus, the electrolytic production of bichromates from chromates, persulphates from sulphates, chloroform from alcoholic sodium chloride is considerably facilitated. B. W. C.

2635. *Conductivity of Metallic Colloids and its Electro-technical Applications.* **H. André.** (Comptes Rendus, 181. pp. 243–244, Aug. 10, 1925.)—In electrolysing concentrated sulphuric acid by means of two pure silver electrodes connected with an alternating current source, the resistance of the liquid diminishes progressively during the passage of the current, as does the electrolysis, which ceases when the difference of potential between the electrodes is thus annulled. The sulphuric acid assumes a yellowish-brown tint, and ultramicroscopic examination reveals threads of colloidal silver endowed with brownian movements of rotation and translation. Orthophosphoric acid gives the same result and the silver may be replaced by graphite. With a colloidal silver electrode and another metal with an isolating and unattackable oxide we get a current rectifier suitable for recharging accumulators, or a polarised relay. The maximum disruptive tension which the kathode will bear in a concentrated sulphuric medium is comparatively the same for different metals and frequently attains 100 volts. Rapidity of oxidation being very variable, the choice of kathodic substances is limited. The efficient tension restored by various kathodes is as follows : pure copper, 8 volts ; nickel, 16 ; ferronickel (50 %), 18 ; soft iron, 25 ; ferrosilicon, 35 ; silicon, 80. Unilateral conductivity necessitating an inverse reoxidising current, the form of the tension curve greatly influences the action. The presence of a counter-electromotive force in the rectifier circuit is favourable to a good commutation. Thermionic action may be obtained by drying the colloids. The current is then established at a temperature of 300° to 400° C. and ceases on cooling. Interruptions of the current are accompanied in these unilateral conductors by oscillations of high frequency. E. F.

2636. *Hydrogen and Oxygen Electrode Titrations of some Dibasic Acids and of Dextrose.* **H. T. S. Britton.** (Chem. Soc., J. 127. pp. 1896–1917, Aug., 1925.)—Previous work on the ionisation of dibasic acids had been confined to solutions containing free acids or acid salts ; the solutions which were typical of the whole course of neutralisation had not been studied [see Abstract 2637 (1924)]. In the present investigation, the course of neutralisation of oxalic, malonic, succinic and tartaric acids and dextrose was studied at 18° C. by electrometric methods. It was found that the four acids, in the course of their neutralisation, produce hydrogen ion concentrations which extend over the whole acid zone, and therefore partially neutralised solutions may be used for reference purposes in colorimetric determinations of P_H. The

dissociation constant of dextrose as a monobasic acid was determined. Formulæ have been derived for the calculation of the dissociation constants of dibasic acids from the hydrogen electrode titration curves. It was shown that formulæ obtained by Auerbach and Smolczyk give less accurate results, and that the identity $K_1K_2 = h^2$, where h is the hydrion concentration at the mid-point of the titration curve, is erroneous. Attempts were made to use the oxygen electrode for the purpose of indicating hydrion concentrations in titrations. F. J. B.

2637. *New Method of Potentiometric Titration.* **E. Zintl,** with experiments by **A. Rauch.** (Zeits. Elektrochem. 31. pp. 428–430, Aug., 1925. Paper read before the Deut. Bunsen Gesell., Darmstadt, May, 1925.)—Experiments were made on two examples of the precipitation of a metal, by a strong reducing agent. The examples studied were the precipitation of gold and bismuth by a solution of titanium chloride. The titanium chloride solution was standardised by means of a ferric salt in acid solution, and potassium permanganate or by a copper sulphate solution. Copper salts are instantaneously reduced to the cuprous state by titanious chloride, and the end point of the reduction is denoted by a sharp rise of potential. It is possible to estimate gold and copper in one operation. F. J. B.

2638. *Activity of Strong Electrolytes. IV. Application of the Debye-Hückel Equation to Alcoholic Solutions.* **G. Scatchard.** (Am. Chem. Soc., J. 47. pp. 2098–2111, Aug., 1925.)—Extending Debye's theory, Hückel has taken into account the electric charges, the diameter of the ion and the change of the dielectric constant with the change of the concentration of the electrolyte. The equation deduced [Abstract 1267 (1925)] admits of extrapolating to zero concentration even when measurements of very dilute solutions are not available. The activity coefficient being much greater in alcoholic than in aqueous solutions, the author, after recalculating Hückel's values for aqueous hydrochloric acid on the basis of the most recent data, applies the equation to solutions of hydrogen chloride in alcohol and alcohol-water mixtures. He finds the agreement even better than expected for solutions ranging from 50 mol. % alcohol down to at least 1 mol. The experiments are made by e.m.f. measurements in cells Pt, H_2 | HCl, AgCl | Ag and confirmed by e.m.f. measurements on solutions of lithium chloride in ethyl and methyl alcohol and water and by solubility determinations of sodium chloride in ethyl alcohol and water. For these salts the variation of the activity of the ions in ideally dilute solutions in different solvents is fully explained. For hydrogen chloride this variation indicates the formation of the hydrated ion H_3O^+; only one molecule of water seems to enter into the reaction. As it is improbable that the change in activity with changing solvent is the same for the potassium ion as for the chloride ion, the change with changing salt concentration need not be the same for the two ions in a single solvent. [For Parts I to III see Abstract 1770 (1925).] H. B.